CRUCIBLE STEEL COMPANY OF AMERICA

JOHN B. HABERLE

CRUCIBLE STEEL COMPANY OF AMERICA

GENERAL OFFICES:

17 East 42nd Street

New York, N. Y.

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FOREWORD

The remarkable development which has recently taken place in the production of certain grades of steel and in their economic use in shop practice, is an illustration of the rapid evolution going on in steel-making and in the related mechanic arts.

The uses to which steel—that potent metal—is itself applied are enlarging daily, while the importance of its application to the shaping and preparation of the many other materials of construction can hardly be overestimated.

As the uses and applications multiply, the steel-maker is called upon, not only to provide a greater variety of kinds and qualities than ever before, but he is also expected to meet to perfection a host of most exacting requirements.

It is clear that this involves a great responsibility.

The Crucible Steel Company of America is prepared to meet this responsibility and these requirements to the present limit of the steel-making art.

Its mills have attained a high measure of success in fine steel production. They comprise an adequate and self-contained group so located as to afford convenient and economical facilities for handling supplies and product. Its specialized resources include the latest developments in metallurgical processes and machinery, yet it holds fast also to those old and tried methods which have shown their utility and value since the early days of the industry, a century and more ago. And what is of equal importance, the management has secured in every department a force of competent steel-makers and workers, practical men whose lives have been devoted to the mastery and perfection of this difficult craft. Supplementing a skilled operating staff, it has a technical corps of chemists, mechanical and metallurgical engineers—men of ability and experience, careful observers, used to exact methods and scientific accuracy.

This catalogue is offered as a guide to users of high grade steel and in the belief that consumers are alert to recognize the value of GOOD STEEL. The abundant and increasing patronage during the years since this Company was organized gives proof of the high quality of its output and encourages the management to further develop its practice and product.

PLANTS

Park Steel Works	Pittsburgh, Pa.
Crescent Steel Works	Pittsburgh, Pa.
La Belle Steel Works	Pittsburgh, Pa.
Singer-Nimick Steel Works	Pittsburgh, Pa.
Sanderson Steel Works	Syracuse, N. Y.
Emerson Avenue Works	Syracuse, N. Y.
Atha Steel Works	Harrison, N. J.
Ordnance Works	Harrison, N. J.
Spaulding & Jennings Works	Jersey City, N. J.
Spring Works	McKees Rocks, Pa.

SALES OFFICES AND WAREHOUSES

Baltimore, Md.	Montreal, Canada
Boston, Mass.	New Haven, Conn.
Buffalo, N. Y.	New York, N. Y.
Chattanooga, Tenn.	Philadelphia, Pa.
Chicago, Ill.	Pittsburgh, Pa.
Cincinnati, Ohio	Providence, R. I.
Cleveland, Ohio	San Francisco, Calif.
Denver, Colo.	Seattle, Wash.
Detroit, Mich.	Springfield, Mass.
Hartford, Conn.	St. Louis, Mo.
Indianapolis, Ind.	St. Paul, Minn.
Milwaukee, Wis.	Syracuse, N. Y.

Toronto, Canada

London Tokio

FACILITIES FOR THE PRODUCTION OF HOT AND COLD ROLLED, COLD DRAWN, FORGED, ROUGH TURNED AND MACHINED, ANNEALED, HEAT TREATED AND TEMPERED STEELS. MARKET AND USES FOR SUCH PRODUCTS.

FACILITIES	PRODUCTS	MARKET Manufacturers of Machinery, Implements and Tools for	USES
MINES	Coal Limestone	AGRICULTURE	Corn cutters, coulters, discs, forks, guard plates, harvesting machinery, hoes, plowshapes, rakes, section scythes, springs.
		AUTOMOTIVE MANUFACTURING	Axles, balls and bearings, crank shafts, drive shafts, gears, magnets, pinions, springs, valve springs.
COKE OVENS	Coke, gas, tar Sulphate of ammonia Ammoniacal liquor Benzol, toluol Light oil distillates	BUILDING TRADES	Axes, boilermakers' tools, carpenters' and masons' tools, hatchets, pneumatic hammers, rivets, rivet sets.
		CUTLERY MANUFACTURING	Files, forks, knife back springs, pocket knives, razors (safety and other), scissors, table knives.
		DROP FORGING	Crank shafts, die blocks, piston rods, trimmer dies.
BLAST FURNACES	Basic pig iron	EDGE TOOL MANUFACTURING	Axes, auger bits, chisels, cold chisels, files, hatchets, plane bits, saws (cross-cut, circular, band, gin, hack, hand screw slotting.)
		ELECTRICAL MANUFACTURING	Forgings, magnets, pole pieces and shoes, resistance wire, shafting, sheets, telephone and radio equipment, welding rods.
		JEWELRY MANUFACTURING	Drawing arbors, engravers' plates, engravers' tools, hardened rolls, punches and dies, special tools.
CRUCIBLE FURNACES ELECTRIC FURNACES OPEN HEARTH FURNACES	Ingots	LUMBERING	Axes, cant-hooks, sledges, special machinery, saws (circular, cross-cut, gang, hand).
		MACHINE TOOL MANUFACTURING	Axles, forgings, gears, lathe centers, pinions, shafts and other machine parts, special machinery.
		MARINE EQUIPMENT	Forgings (rough and finished for crank shafts), fire box, and tank plates, propellers, thimble steel, turbines.

BLOOMING MILLS	Blooms Billets Slabs	METAL SPECIALTIES	Brush wire, calipers, corset wire, electric horns, electric bells, locks, micrometers, pens, polished drill rods, rezistal steel for cooking utensils, safety stair treads, special spring steel, surgical and dental instruments, tape lines, thermostat diaphragms, trusses, umbrella ribs.
		MINING AND SMELTING	Coal auger bits, crushing bars and balls, furnace bars, furnace pokers, mine bits, picks, shovels, solid and hollow drills.
		MUSICAL INSTRUMENT MFRS	Phonograph needle wire and springs, keys, tempered springs.
		OIL DRILLING	Bits, box and pins, capping, jars and stems for drills.
FINISHING MILLS	Bars Rods Wire Sheets Springs (coil and elliptic) Shapes	ORDNANCE AND MUNITIONS	Armor piercing projectiles, bayonets, bullet steel, bullet-proof steel, gun forgings, periscope tubes, rifle barrels, torpedo tubes.
		PAPER MANUFACTURING	Beater bars, bed plates, jordan bars, knives.
		RAILROADS	Axles, forgings, spring steel, track bolts, track chisels, springs (finished, coil and elliptic for locomotives and cars).
		RUBBER MANUFACTURING	Dies, forgings, moulds, tools.
		SCALE MANUFACTURING	Bearings, frames, pivots, springs.
		SHOE AND LEATHER MANUFACTURING	Belt knives, cutting tools, shoe dies, shoe shanks, sewing machine needle wire.
		SMALL TOOL MANUFACTURING	Broaches, dies, drills, gauges, hobbs, milling cutters, punches, reamers, taps.
FORGING PRESSES AND HAMMERS	Bars Die blocks Forgings	SPORTING GOODS MANUFACTURERS	Fish hooks, fish rods, golf clubs, revolver barrels and parts, shotgun and rifle barrels, skates.
		STEEL MANUFACTURERS	Drawing dies, forgings, finished hardened rolls, roll turning tools, wire drawing plates, wortle dies.
		TEXTILE MANUFACTURING	Heddle bar and wire, needle wire, rollers, shuttles, shuttle springs, spindles, tips.
		TYPEWRITER MANUFACTURING	Bell and ball steel forging and forming steel, screws, springs, type bars.
		VAULT, SAFE AND JAIL BUILDING	Jail bars (5-ply or laminated), plates (laminated), reinforcing bars (5-ply or laminated and hardened).
MACHINE SHOPS	Machined products	WATCH AND CLOCK MANUFACTURING	Case springs, hands and watch parts, main springs, punches, dies.

TERMS AND CONDITIONS OF SALE

Terms are net cash within 30 days from date of Invoice.

All prices are F.O.B. Seller's Mill or Warehouse.

Quotations are for immediate acceptance and prices are subject to change without notice.

Orders and contracts are accepted with the understanding that serious fires, strikes, differences with workmen, accidents to machinery or other causes unavoidable or beyond our control shall excuse any delay caused thereby in executing orders.

Checks and drafts should be drawn to the order of Crucible Steel Company of America, and forwarded to the Treasurer at 17 East 42nd St., New York, N. Y.

Any steel proving defective in the hands of the buyer will be replaced, ordinary shop loss excepted, but no claims for labor or damages will be allowed.

HOW TO ORDER STEEL

Much time can be saved and many mistakes can be avoided by taking pains to see that all the necessary details are properly given when ordering steel. We believe the following recommendations will be helpful to our customers in properly making up their orders:

SPECIFY ON EVERY ORDER PURPOSE FOR WHICH THE STEEL IS TO BE USED

QUANTITY REQUIRED:—State quantity required in pounds, or in feet, or in number of pieces.

SIZE REQUIRED:—State carefully the section or shape, such as round, square, flat, octagon or special. Also give dimensions, such as diameter, width and thickness of flat sections, distance across flats on octagons. Special shapes should be sketched and dimensioned carefully. State whether round or square edges are required; if round edges, give width of section and whether size desired is measured on the flat or over all. Specify any special tolerances on dimensions, which may be required.

GRADE AND TEMPER:—Specify grade wanted and state whether Hot Rolled, Rough Turned, Cold Rolled or Cold Drawn bar is desired; also whether the material is desired in the natural, annealed, or heat treated and annealed condition. Also outline in as great detail as practicable how material is to be used—whether for hot forging or cold forming, for machining or use in automatic machines, or whether the material is to be used without any heat treatment.

In ordering Machinery or Alloy Steels for special purposes any specifications as to the tensile values or hardness desired will be helpful in supplying steel for particular requirements. In fact these details are vitally important in furnishing proper steel for such uses.

In ordering steel for Die Blocks, Gear Blanks, Shafts, Forgings, etc., which are to be subsequently machined, state whether the sizes given are the rough or finished dimensions.

When ordering Annealed Tool Steel on which a hard surface is necessary after hardening, it is essential that ample allowance be made for removing all decarbonized surface metal.

ALLOWANCE FOR FINISHING:—It is unwise to cut the allowance too fine between the forged or rolled size and the finished size of the tool required. The following may be taken as a guide:

In sizes 1″ and under, the allowance should be at least						$\frac{1}{32}$″
Over 1″ to 2″	"	"	"	"	"	$\frac{1}{16}$″
Over 2″ to 3″	"	"	"	"	"	$\frac{1}{8}$″
Over 3″ to 4¾″	"	"	"	"	"	¼″
Over 4¾″ to 8″	"	"	"	"	"	$\frac{3}{8}$″

These allowances should insure absolute safety from soft spots.

Great care should be taken to see that the steel is well centred, so that in the turning down operation the allowance for finishing is taken off fairly evenly all over.

Give full and complete shipping instructions, routing, and manner of packing or boxing desired. Boxing, crating, packing, etc., is charged extra to you at cost.

HIGH SPEED STEEL

Furnished in Bars, Hot Rolled, Cold Rolled and Cold Drawn, Rounds, Squares, Octagons, Flats, Single and Double Bevels, Special Shapes.

Blocks, Blanks, Discs and Rings.

Hardened Bars and Tool Holder Bits ready for use.

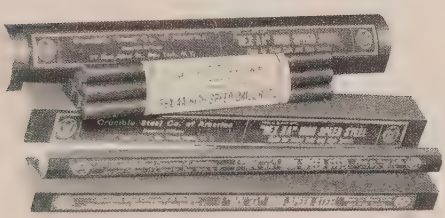
High Speed Steel Sheets, Hot and Cold rolled.

Circular Plates for Saws.

Ground, Polished, Lime Drawn or Rough Drawn High Speed Drill Rods—furnished in standard three foot bars or in special lengths.

High Speed Steel in Annealed Special Forgings furnished for particular purposes. Sketches should be supplied with inquiries.

REX "AA" HIGH SPEED STEEL



The many years that this Company has devoted to the development and perfection of High Speed Steel have resulted in Rex "AA", which is today acknowledged as standard among users of such material.

The success of Rex "AA" High Speed Steel is due to maintaining the highest standards in the selection of raw materials and continuing through every stage of manufacture, which is constantly watched by trained metallurgists and practical steel men.

Rex "AA" High Speed Steel is used in making tools and dies to yield the utmost in service. It will take heavy cuts at the maximum speed of which the machine tool is capable. It is unequalled in strength and endurance and meets every demand of modern machine shop practice. It is chemically correct and physically sound. It forges with great ease, is quickly responsive to heat treatment in an unusually wide temperature range and possesses uniform hardening properties.

We carry at all of our Branches a stock of standard sizes of annealed bars for taps, reamers, twist drills, etc. Special sizes and shapes are also supplied promptly from our various Mills. Discs of any length will be delivered by cutting from bars in stock at our various Warehouses. When ordering discs, always state whether the size specified is the finished or unfinished size.

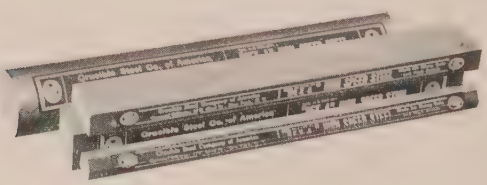
The price of Rex "AA" High Speed is subject to High Speed Classification of Extras, as shown on pages 24–25.

Some of the purposes for which this steel is extensively used are:

Lathe, Planer and Boring Tools	Dies
Twist and Flat Drills	Blank and Screw Cutting Dies
Gun Barrel, Rail and other Drills	Inserted Reamer Blades
Reamers	Segmental Taps
Milling Cutters	Formed Milling Tools
End Mills	Intricate Special Cutters
Slotting Cutters	Hobbs
Threading Cutters	Broaches
Gear Cutters	Chasers

It is also being extensively used for dies for forming Hot Iron and Steel. Among them may be mentioned Bolt and Rivet Dies, Gripping Dies, Domino or Heading Tools, Nut Piercers, Nut Boxes, Crowning Tools, Shear Blades, Cut-Offs, Swedging Dies, Spike Cutters and Hot and Cold Punches.

Rex "AA" High Speed Steel has also been very successful for certain classes of tools for Stone Work, Wood Working Machinery Knives and for Forming Tools for Tin and Sheet Metal Work, Rubber and Glass.



HIGH SPEED STEEL

REX "A" REX "AA"

SUGGESTIONS FOR TREATMENT

CUTTING:—Annealed High Speed Steel should be machine cut, or cut with a hack saw. Unannealed High Speed Steel must be cut hot. Heat the piece thoroughly to a yellow heat, use a sharp chisel and cut through. (Do not "nick and break").

FORGING:—Heat slowly and uniformly to a yellow heat, about 1800° to 2000° F., at which temperature the steel will flow freely under the hammer; reheat as often as is necessary to maintain this condition. High Speed Steels are hard at the cherry heats, and consequently if forging is carried into these heats, forging strains with a subsequent breakage will result.

ANNEALING:—In annealing High Speed Steel, use an iron box or pipe, of sufficient size to allow at least one-half inch of packing between the piece of steel to be annealed and the walls of the container. Pack carefully in fine dry lime or mica chips and cover with a cap or lid. The lid should be fairly tight; if not, lute with fire clay. Heat slowly to a clear red heat (about 1550° F.) for two hours, then drop the temperature to 1350° F. and hold for about six hours, and then allow the steel to cool down with the furnace.

GRINDING:—A free cutting wheel, either wet or dry, should be used. Avoid undue pressure in this process or the steel will be "blue" in spots. This condition will develop strains and grinding cracks, which will probably result in breakage.

HARDENING:—In the hardening of High Speed Steel good judgment is necessary, and we know of no point in the working of steel where the personal equation stands for so much.

First preheat the tools slowly, thoroughly and uniformly to some temperature between 1450° and 1650° F., then transfer to a much hotter fire and heat rapidly to a white heat or until the cutting edge fluxes or sweats freely, in appearance similar to borax when welding. Recommended temperatures for hardening are from 2250° to 2400° F. For tools where the retention of form and size is necessary, preheat to between 1350° and 1450° F., or below the scaling point.

When it is possible, two furnaces should be used; one for preheating and one for final or superheating.

The character of the tool and of the fire or furnace must be taken into consideration. Do not permit flame to strike the tool directly.

Avoid an oxidizing, cutting flame by using an excess of fuel rather than excess air. Neglect of these precautions results in oxidation and decarbonization of the steel. High Speed Steel is best when hardened from a high heat but it should not be left exposed to this high heat one second longer than is absolutely necessary. Prolonged heating or soaking at the higher temperatures promotes grain growth, weakened structure and cracks in quenching. After the tool has been brought rapidly to the required temperature, remove it promptly from the fire and quench in either good thin oil, in a dry air blast, or in a bath of molten lead or salt at about 1100° F. After remaining in this hot bath a few minutes, remove and cool in the air.

DRAWING:—Draw the tool as soon after quenching as convenient. Proper temperature is at 1000° to 1150° F., depending on the degree of hardness and toughness desired. The fact that the tool has been quenched in a molten bath, the heat of which is equivalent to the proper drawing temperature, does not eliminate the necessity for subsequent drawing. Hardening and drawing are two distinct operations and should be carried out as such.

REX "AAA" HIGH SPEED STEEL

Rex "AAA" is a Cobalt High Speed Steel. It possesses extraordinary properties which insure long service, increased output and general shop economy. It is especially recommended for very heavy cuts which develop high frictional temperatures. Cobalt High Speed Steels have not met with the success which their merits warrant when properly hardened, owing to the experience of users in the development of a soft skin on the hardened tools. The formation of this skin, however, is not unavoidable and numerous Rex "AAA" forming tools have been hardened without showing a soft surface or distorting in form, even though they had been hardened by the open fire method at temperatures from 2400° to 2450° F. Good furnace conditions are necessary in the treatment of this steel, for in order to secure the maximum efficiency from it, it is necessary to harden at temperatures averaging 75 to 100 degrees higher than for Rex "AA".

Rex "AAA" is furnished in rounds, squares and flats; in bars, hardened and ready for use, and in Tool Holder Bits as shown on page 20. The price of Rex "AAA" High Speed Steel is subject to Classification of High Speed Extras, as shown on pages 24-25.

SUGGESTIONS FOR TREATMENT OF REX "AAA" HIGH SPEED STEEL

FORGING:—This steel is denser than Rex "AA" and heating for forging should be done with special care. All High Speed Steels have a low rate of heat conductivity and more time is needed to successfully heat them than is required for Carbon Steels. Non-uniformity in heating for forging is the most frequent cause of cracks which sometimes do not appear until after hardening. For best results from the finished tool, the forging temperature should not exceed 2000° F. (a light orange to dark yellow heat); heat slowly; allow for uniform penetration throughout. Thus heated, the steel will flow freely under the hammer. Do not work below 1550° F. as forging strains will be developed. If a forge fire is used, see that it is clean and a good body of fuel surrounding the piece to prevent direct contact with the blast. If heated in a furnace maintain a neutral or reducing atmosphere; also avoid direct contact with the flame or blast. Oxidizing conditions in heating are detrimental to any steel.

HARDENING:—Preheat according to instructions given for Rex "AA" (page 15). The superheat, or final heat, for hardening should be carried somewhat higher than is necessary for Rex "AA" and for maximum cutting qualities a temperature of 2375° to 2450° F. is recommended.

QUENCHING AND DRAWING:—These operations should be conducted along the same lines as recommended for Rex "AA".

CHAMPION HIGH SPEED STEEL

Champion High Speed Steel is a highly specialized product capable of developing a hardness which recommends its use for tools which have to cut harder and tougher materials, such as Alloy Steels, Hard Cast Iron and Heat Treated Steels. Its great natural hardness gives it a high resistance to abrasion and enables it to produce a very fine finish even when working at high speeds. This characteristic is peculiar to Champion High Speed Steel.

The price of Champion High Speed Steel is subject to High Speed Classification of Extras, as shown on pages 24–25.

RECOMMENDATIONS FOR TREATMENT OF CHAMPION HIGH SPEED STEEL

FORGING should be conducted along the same lines as recommended for Rex "AA".

HARDENING:—Preheat as recommended for Rex "AA". The superheat or final heat recommended is 2250° to 2350° F. At these temperatures the cutting portion of the tool has reached a light even sweat.

QUENCHING AND DRAWING should be conducted along the same lines as recommended for Rex "AA", but a slightly higher maximum drawing temperature is permissible.

HIGH SPEED STEEL TREATED BITS FOR TOOL HOLDERS

REX "AAA" REX "AA" CHAMPION

We carry at our Branches and Mills the regular or commercial sizes of High Speed Steel Bits, Hardened, Ready for Use. These Bits fit securely and can be made rigid in any of the standard makes of tool holders. To secure maximum efficiency, all Tool Holder Bits should be ground thoroughly before being placed into service. All Bits are put up in boxes of about five pounds of a size, as follows:

STANDARD SIZES AND LENGTHS

$\frac{3}{16}$	inch	square,	$2\frac{1}{2}$	inches	long,	$\frac{7}{16}$	inch	square,	$3\frac{1}{2}$	inches	long
$\frac{1}{4}$	"	"	$2\frac{1}{2}$	"	"	$\frac{1}{2}$	"	"	4	"	"
$\frac{5}{16}$	"	"	$2\frac{1}{2}$	"	"	$\frac{9}{16}$	"	"	4	"	"
$\frac{3}{8}$	"	"	3	"	"	$\frac{5}{8}$	"	"	$4\frac{1}{2}$	"	"

$\frac{3}{4}$ inch square, 5 inches long

The above lengths (with 30-degree bevel on each end) will be furnished, unless otherwise specified. Special sizes, shapes and lengths can be furnished.

APPROXIMATE NUMBER OF BITS PER POUND

$\frac{3}{16}$	inch	square—	36	Bits	to	One pound
$\frac{1}{4}$	"	"	—20	"	"	"	"
$\frac{5}{16}$	"	"	—13	"	"	"	"
$\frac{3}{8}$	"	"	— 8	"	"	"	"
$\frac{7}{16}$	"	"	— 5	"	"	"	"
$\frac{1}{2}$	"	"	— 3	"	"	"	"
$\frac{5}{8}$	"	"	— 2	"	"	"	"
$\frac{3}{4}$	"	"	— 1	Bit,	approx.	$\frac{3}{4}$	pound

SPECIAL SHELL TURNING TOOL BITS represent a development to meet a demand for the highest grade of treated tools, ready for use, for turning heat treated shells. These bits have been found very efficient where heavy cuts and slow speeds are used, on cast iron and hard forgings, or bars.

HIGH SPEED STEEL HARDENED LENGTHS FOR TOOL HOLDERS

A complete stock of small squares, up to one (1) inch, inclusive, and Single and Double Bevels, in three (3) foot lengths, Hardened Ready for Use, is carried at all our Branches.

These bars should not be heated when cutting to length. They should be nicked on a sharp emery wheel, broken off to the length desired, and then ground to the required cutting shape.

Prices are subject to High Speed Steel Classification of Extras, as shown on pages 24–25.

BEVELED SIZES CARRIED IN STOCK

½ inch x $\frac{3}{32}$ inch	⅞ inch x ⅛ inch	1½ inch x $\frac{3}{16}$ inch
⅝ " x $\frac{3}{32}$ "	1 " x ⅛ "	1 " x ¼ "
⅝ " x ⅛ "	⅞ " x $\frac{3}{16}$ "	1¼ " x ¼ "
¾ " x ⅛ "	1 " x $\frac{3}{16}$ "	1⅜ " x ¼ "
¾ " x $\frac{3}{16}$ "	1⅛ " x $\frac{3}{16}$ "	1⅜ " x $\frac{5}{16}$ "

This steel is beveled about $\frac{1}{32}$ inch on each side for clearance.

HIGH SPEED SHEET STEEL

Rex "AA" High Speed Sheet Steel is adapted to and extensively used for Milling, Slotting and Slitting Saws, small thin Cutters and tools of like description. Usually furnished in annealed sheets, 10″ to 14″ wide, so they can be sheared, drilled and blanked the same as any regular tool steel sheet, but if so desired it can be supplied sheared into strips, preferably not less than 4¼″ wide. When ordering in strips, if the steel is intended for saws, sufficient stock must be added to the width to allow for proper finishing, for example: 4¼″, 6⅜″ or 8⅜″ wide, for saws 4″, 6″ or 8″ diameter respectively. It is very essential that a liberal allowance be made for surface grinding, to insure perfect surface hardening of Milling Tools or Slotting Saws intended for accurate slotting work, as indicated by the following sizes, usually carried in stock:

.056″ for $\frac{1}{32}$″ thick Slotting Saws
.075″ " $\frac{3}{64}$″ " " "
.088″ " $\frac{1}{16}$″ " " "
.123″ " $\frac{3}{32}$″ " " "
.155″ " $\frac{1}{8}$″ " " "
.186″ " $\frac{5}{32}$″ " " "
.215″ " $\frac{3}{16}$″ " " "

High Speed Sheet Steel will be furnished at Base Price for Bars, plus following Extras:

.165 thick and heavier		10 cents per pound extra
.095 to .164 inclusive		15 cents per pound extra
.072 to .094	"	20 cents per pound extra
.058 to .071	"	25 cents per pound extra
.049 to .057	"	30 cents per pound extra
.042 to .048	"	35 cents per pound extra
.035 to .041	"	40 cents per pound extra

Lighter gauges, prices upon request.

Extra for shearing to widths 2″ and wider . . . . . 2 cents per lb.
Extra for annealing . . . . . 2 cents per lb.
Base Size Sheets measure 10″ to 14″ wide by 4 ft. to 5 ft. long.

COLD ROLLED HIGH SPEED SHEET STEEL:—Prices on request.

HIGH SPEED STEEL

Standard Classification of Extras

All Dimensions Inclusive

Intermediate sizes take the next higher extra

BASE SIZES

ROUND, SQUARE AND OCTAGON

⅝ inch to 2 inches inclusive

FLAT

⅝ inch to 2 inches thick by ⅝ inch to 2 inches wide

EXTRA SIZES

ROUND, SQUARE AND OCTAGON

Inches	Extra per Lb. Cents	Inches	Extra per Lb. Cents
9/16 to ½	2.0	3⅝ to 4	3.5
7/16 to ⅜	3.5	4⅛ to 4½	4.0
5/16 to 11/32	6.0	4⅝ to 5	4.5
¼ to 9/32	8.5	5⅛ to 5½	5.0
2⅛ to 2½	2.0	5⅝ to 6	5.5
2⅝ to 3	2.5	6⅛ to 6½	6.0
3⅛ to 3½	3.0	6⅝ to 7	6.5

Annealing ..... 2c. per lb. extra

HIGH SPEED STEEL

Standard Classification of Extras

All Dimensions Inclusive

Intermediate sizes take the next higher extra

EXTRA SIZES

FLAT

Inches	Extra per Lb. Cents	Inches	Extra per Lb. Cents
1/8 x 3/16	40.0	3/8 x 1 5/8 to 5	2.5
1/8 x 1/4	30.0	7/16 x 1/2 to 1	3.0
1/8 x 5/16	20.0	7/16 x 1 1/8 to 5 1/2	2.5
1/8 x 3/8 to 2	14.0	1/2 x 5/8 to 1	2.5
3/16 x 1/4 to 3	14.0	1/2 x 1 1/8 to 6	2.0
1/4 x 5/16 to 1/2	8.0	9/16 x 5/8 to 1	2.5
1/4 x 5/8 to 1	5.0	9/16 x 1 1/8 to 6	2.0
1/4 x 1 1/8 to 4	3.0	5/8 to 2 x 5/8 to 2	0.0
5/16 x 3/8 to 5/8	5.0	5/8 to 2 x 2 1/8 to 4	2.0
5/16 x 3/4 to 1	3.5	5/8 to 2 x 4 1/8 to 7	4.0
5/16 x 1 1/8 to 4 1/2	3.0	2 1/8 to 3 x 2 1/8 to 4	2.0
3/8 x 7/16 to 3/4	3.0	2 1/8 to 3 x 4 1/8 to 7	4.0
3/8 x 7/8 to 1 1/2	3.0		

Annealing ..... 2c. per lb. extra

High Speed Steel Bars, Hardened, Ready for Use, 10c. per pound extra for Hardening.

Bevels, same Classification as flats, plus 10c. per pound for shape.

Cutting to Specified Single and Multiple Lengths

	Per Lb. Cents
24 inches and over	1.0
18 inches to 23 15/16 inches	2.0
12 inches to 17 15/16 inches	3.0
6 inches to 11 15/16 inches	4.0

Less than six inches—Special Price

HIGH SPEED STEEL

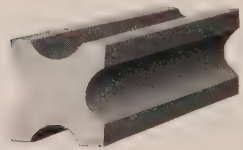
SPECIAL SHAPES

When desired, High Speed Steel will be furnished, Hot Rolled, in standard sizes of the Cruciform, Beaded and Grooved sections; and in numerous other special shapes, Hot Rolled or Cold Drawn.

HIGH SPEED ROLL TURNING TOOLS

REX "AA" REX "AAA"

CHAMPION



Furnished Fluted, Hardened and Ground ready for use. All standard sizes and lengths.

HIGH SPEED STEEL

CLASSIFICATION OF FORGED DISCS

	Extra per Lb. Cents
Weighing above 25 pounds	6
Weighing 15 to 25 pounds	10
Weighing 10 to 15 pounds	12
Weighing 7½ to 10 pounds	14
Weighing 5 to 7½ pounds	16
Weighing 3 to 5 pounds	18
Weighing 2 to 3 pounds	22
Weighing 1 to 2 pounds	24
Annealing	2c. per lb. extra

HIGH SPEED STEEL

CLASSIFICATION OF FORGED DIE BLOCKS

	Extra per Lb. Cents
Weighing above 25 pounds	4
Weighing 15 to 25 pounds	6
Weighing 10 to 15 pounds	10
Weighing 7½ to 10 pounds	14
Weighing 5 to 7½ pounds	16
Weighing 3 to 5 pounds	18
Weighing 2 to 3 pounds	22
Weighing 1 to 2 pounds	24
Annealing	2c. per lb. extra

HIGH SPEED STEEL DRILL RODS

ACCURATE IN SIZE
PERFECT IN FINISH
SUPERIOR IN QUALITY

Will Make Excellent Taps, Reamers, Drills, Punches, etc.

Furnished in Special Lengths or in Standard Three-Foot Bars.

Made in About 200 Sizes of Round Rods or Wire ranging from 1½″ down to No. 80 (.0135″) in Diameter.

GROUND, POLISHED OR LIME DRAWN DRILL RODS OF HIGH SPEED STEEL

Size	Equivalent in Decimals	Feet per Pound	Price per Pound
1 1/2	1.500	.....	$1.40
1 31/64	1.4843	.....	1.40
1 15/32	1.4687	.....	1.40
1 29/64	1.4531	.....	1.40
1 7/16	1.4375	.....	1.40
1 27/64	1.4218	.....	1.40
1 13/32	1.4062	.....	1.40
1 25/64	1.3906	.....	1.40
1 3/8	1.375	.....	1.40
1 23/64	1.3593	.....	1.40
1 11/32	1.3437	.....	1.40
1 21/64	1.3281	.....	1.40
1 5/16	1.3125	.....	1.40
1 19/64	1.2968	.....	1.40
1 9/32	1.2812	.....	1.40
1 17/64	1.2656	.....	1.40
1 1/4	1.250	.....	1.40
1 15/64	1.2343	.....	1.40
1 7/32	1.2187	.....	1.40
1 13/64	1.2031	.....	1.40
1 3/16	1.1875	.....	1.40
1 11/64	1.1718	.....	1.40
1 5/32	1.1562	.....	1.40
1 9/64	1.1406	.....	1.40
1 1/8	1.125	.....	1.40
1 7/64	1.1093	.....	1.40
1 3/32	1.0937	.....	1.40
1 5/64	1.0781	.....	1.40
1 1/16	1.0625	.....	1.40
1 3/64	1.0468	.....	1.40
1 1/32	1.0312	.....	1.40
1 1/64	1.0156	.....	1.40

GROUND, POLISHED OR LIME DRAWN DRILL RODS OF HIGH SPEED STEEL

Size	Equivalent in Decimals	Feet per Pound	Price per Pound
1	1.	.....	$1.40
63/64	0.9843	.....	1.40
31/32	0.9687	.....	1.40
61/64	0.9531	.....	1.40
15/16	0.9375	.....	1.40
59/64	0.9218	.....	1.40
29/32	0.9062	.....	1.40
57/64	0.8906	.....	1.40
7/8	0.875	.....	1.40
55/64	0.8593	.....	1.40
27/32	0.8437	.....	1.40
53/64	0.8281	.....	1.40
13/16	0.8125	.....	1.40
51/64	0.7968	.....	1.40
25/32	0.7812	.....	1.40
49/64	0.7656	.....	1.40
3/4	0.750	.....	1.40
47/64	0.7343	.....	1.40
23/32	0.7187	.....	1.40
45/64	0.7031	.....	1.40
11/16	0.6875	.....	1.40
43/64	0.6718	.....	1.40
21/32	0.6562	.....	1.40
41/64	0.6406	.....	1.40
5/8	0.625	.....	1.40
39/64	0.6093	.....	1.40
19/32	0.5937	.....	1.40
37/64	0.5781	.....	1.40
9/16	0.5625	.....	1.40
35/64	0.5468	.....	1.40
17/32	0.5312	.....	1.40
33/64	0.5156	.....	1.40

GROUND, POLISHED OR LIME DRAWN DRILL RODS OF HIGH SPEED STEEL

Size	Equivalent in Decimals	Feet per Pound	Price per Pound
1/2	.500	.....	$1.40
31/64	.4843	.....	1.40
15/32	.4687	.....	1.40
29/64	.4531	.....	1.40
7/16	.4375	.....	1.40
27/64	.4218	.....	1.40
Z	.413	.....	1.40
13/32	.4062	.....	1.40
Y	.404	.....	1.40
X	.397	.....	1.40
25/64	.3906	.....	1.40
W	.386	.....	1.40
V	.377	.....	1.40
3/8	.375	2.75	1.40
U	.368	.....	1.40
23/64	.3593	3.00	1.40
T	.358	.....	1.40
S	.348	.....	1.40
11/32	.3437	3.26	1.50
R	.339	.....	1.50
Q	.332	.....	1.50
21/64	.3281	3.59	1.50
P	.323	.....	1.50
O	.316	.....	1.50
5/16	.3125	3.97	1.80
N	.302	.....	1.80
19/64	.2968	4.38	1.80
M	.295	.....	1.80
L	.290	.....	1.80
9/32	.2812	4.89	1.95
K	.281	.....	1.95
J	.277	.....	1.95
I	.272	.....	1.95
H	.266	.....	1.95
17/64	.2656	5.46	1.95

GROUND, POLISHED OR LIME DRAWN DRILL RODS OF HIGH SPEED STEEL

Size	Equivalent in Decimals	Feet per Pound	Price per Pound
G	.261	.....	$1.95
F	.257	.....	1.95
E	.250	.....	2.10
1/4	.250	6.18	2.10
D	.246	.....	2.10
C	.242	.....	2.10
B	.238	.....	2.10
15/64	.2343	7.06	2.10
A	.234	.....	2.10
1	.228	.....	2.10
2	.221	.....	2.20
7/32	.2187	8.06	2.20
3	.213	.....	2.20
4	.209	.....	2.20
5	.2055	.....	2.20
6	.204	.....	2.20
13/64	.2031	9.29	2.20
7	.201	.....	2.20
8	.199	.....	2.20
9	.196	.....	2.20
10	.1935	.....	2.20
11	.191	.....	2.35
12	.189	.....	2.35
3/16	.1875	10.94	2.35
13	.185	.....	2.35
14	.182	11.93	2.35
15	.180	.....	2.35
16	.177	.....	2.35
17	.173	.....	2.35
11/64	.1718	13.07	2.35
18	.1695	.....	2.35
19	.166	14.38	2.35
20	.161	.....	2.35
21	.159	.....	2.35
22	.157	.....	2.45

GROUND, POLISHED OR LIME DRAWN DRILL RODS OF HIGH SPEED STEEL

Size	Equivalent in Decimals	Feet per Pound	Price per Pound
5/32	.1562	15.89	$2.45
23	.154	16.52	2.45
24	.152	16.96	2.45
25	.1495	17.65	2.45
26	.147	18.61	2.45
27	.144	18.91	2.45
9/64	.1406	19.45	2.45
28	.1405	20.01	2.45
29	.136	21.59	2.45
30	.1285	23.97	2.45
1/8	.125	24.75	2.50
31	.120	26.85	2.59
32	.116	29.24	2.71
33	.113	30.82	2.79
34	.111	31.96	2.85
35	.110	32.54	2.88
7/64	.1093	33.16	2.91
36	.1065	34.41	2.97
37	.104	36.45	3.07
38	.1015	37.99	3.15
39	.0995	39.45	3.22
40	.098	41.10	3.30
41	.096	42.84	3.39
3/32	.0937	43.76	3.44
42	.0935	45.80	3.54
43	.089	49.33	3.72
44	.086	53.52	3.92
45	.082	58.94	4.20
46	.081	61.96	4.35
47	.0785	63.56	4.43
5/64	.0781	65.22	4.51
48	.076	68.75	4.69
49	.073	74.95	5.00

GROUND, POLISHED OR LIME DRAWN DRILL RODS OF HIGH SPEED STEEL

Size	Equivalent in Decimals	Feet per Pound	Price per Pound
50	.070	81.24	$5.31
51	.067	88.77	5.69
52	.0635	97.45	6.12
1/16	.0625	99.00	6.20
..	.062	.....	6.20
53	.0595	.....	6.80
54	.055	.....	6.80
55	.052	.....	7.40
56	.0465	.....	7.40
57	.043	.....	9.00
58	.042	.....	9.00
59	.041	.....	9.60
60	.040	.....	9.60
61	.039	.....	10.20
62	.038	.....	10.20
63	.037	.....	10.80
64	.036	.....	10.80
65	.035	.....	11.40
66	.033	.....	11.40
67	.032	.....	12.20
68	.031	.....	12.20
69	.02925	.....	13.00
70	.028	.....	13.00
71	.026	.....	13.80
72	.025	.....	13.80
73	.024	.....	14.60
74	.0225	.....	14.60
75	.021	.....	15.40
76	.020	.....	15.40
77	.018	.....	16.20
78	.016	.....	16.20
79	.0145	.....	17.00
80	.0135	.....	17.00

PEERLESS "A" STEEL

FOR HOT WORK

This is a tungsten steel designed particularly for Hot Heading and Forging Dies, Piercing Tools and Punches, Cut-Offs, Bull Dozing Tools, Swedges, Hydraulic Forging Dies and Gripping Dies.

It retains its hardness to an exceptional degree while hot, and has the added advantage of a counterbalancing toughness.

Notwithstanding its higher price (in comparison with straight Carbon or the cheaper Alloy Steels), it is much more economical to use Peerless "A" since greater and uninterrupted production is obtained.

It is furnished in the annealed condition.

The price of Peerless "A" is subject to High Speed Classification of Extras, as shown on pages 24–25.

SUGGESTIONS FOR HEAT TREATMENT OF PEERLESS "A" STEEL

Heat slowly and thoroughly to about 1500° F., then raise the heat rapidly to about 2000° to 2150° F. Cool naturally in air, in a blast of compressed air, or quench in warm oil, depending on the hardness required. Where oil quenching is resorted to, the parts should not be kept in the oil until cold. They should be kept in the oil only until they reach a temperature of 800° to 900° F. when they should be immediately transferred from the oil to the furnace, and, after again being brought up to 1000/1100° F. should be withdrawn and cooled naturally. In some cases where the tools are large and when air cooling is used, it might not be necessary to draw back after hardening, although it is advisable to draw at 1000° F. for most purposes.

Header dies made from round stock, with an impression in one end only, can readily be hardened in a blacksmith forge by heating back only 1 or 2 inches from the face of the die, leaving the remainder of the die in the unhardened condition.

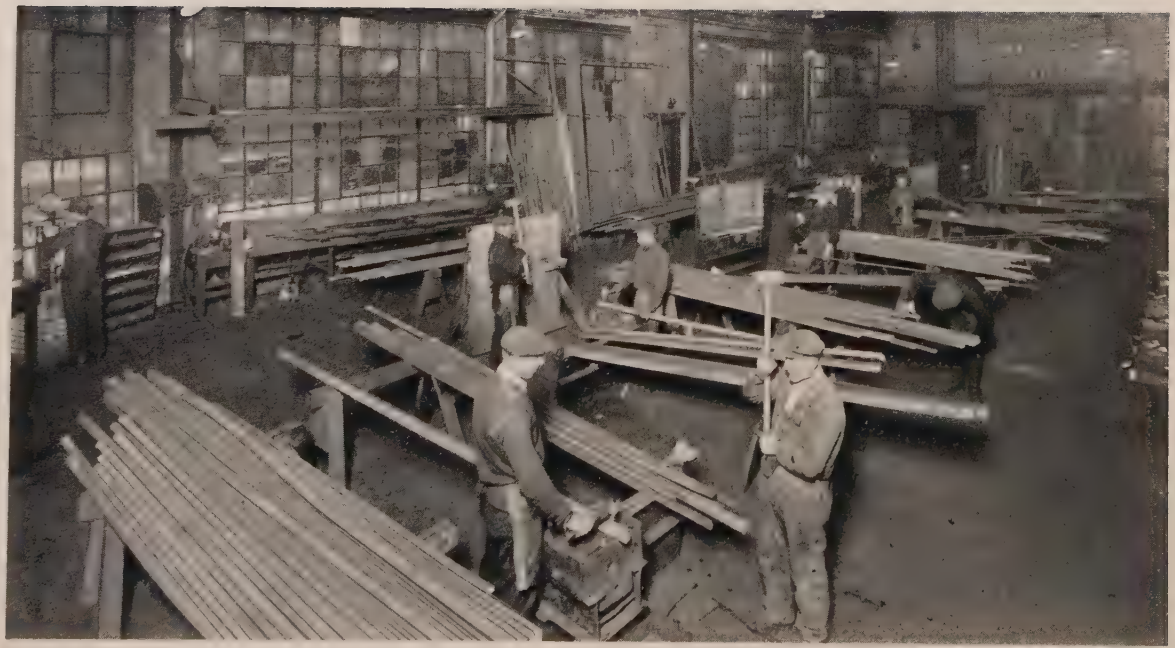
Other parts might also be hardened in the forge, if proper precautions are taken to see that the fire is large enough to hold the entire piece and in good condition. However, the best results will be obtained only when the parts are to be hardened all over—then

two furnaces should be used. The furnaces should be brought to the required temperatures before placing the steel in them. The tools should be held in the preheating furnace long enough to heat thoroughly through. After transferring to the high heat furnace, the piece should never be soaked at the high temperature, but should be held just long enough to bring the surface of the tools up to the required temperature for hardening. This can be determined readily by watching for the "fluxed" condition of the surface.

SELF-HARDENING TOOL STEEL

While this grade of steel can be furnished on demand, we recommend the substitution of High Speed Steel.

The price of Self-Hardening Tool Steel is subject to High Speed Classification of Extras, as shown on pages 24–25.



INSPECTION DEPARTMENT

ALLOY TOOL STEELS

ALLOY TOOL STEELS

For more than one hundred and twenty-five years, "Genuine Crucible Cast Steel" was exclusively used for production of tools of all kinds. During the last quarter of the nineteenth century air-hardening and fast finishing steels were introduced and made some headway, although the plain carbon tool steels of the earlier day were still most largely used. We may consider that the invention of High Speed Steel ushered in the twentieth century and this was followed by the production of many other varieties of alloy tool steels—some of them "special purpose" steels and others for more general application. This may be considered the Age of Alloy Steels, not only tool steels but engineering steels for construction purposes. The evolution of these modern tool steel products has made possible the modern system of great quantity production. Our metallurgists have contributed richly to this work as the following pages descriptive of our Alloy Tool Steel products will disclose.

Carbon tool steels still fill a large place in mechanical processes but they have certain limitations and to overcome these the alloy tool steels have been developed. In general, they permit of greater hardness penetration in tools subjected to great pressure, without the sacrifice of strength. They show greatly increased resistance to wear, an increased durability for tools made from them, and in many cases eliminate the troublesome factor of distortion and size changes. The hardener also has a wider latitude in hardening range and thus the liability of defective work, resulting from restricted temperature ranges, is decreased.

The great advances made during the past few years in the methods of heat treatment have improved the efficiency of carbon tool steels, but at the same time they have clearly indicated their limitations and the next step in increased efficiency and reduced costs results from the use of alloy tool steels.

DOUBLE SPECIAL TOOL STEEL

SANDERSON DOUBLE SPECIAL TOOL STEEL
CRESCENT DOUBLE SPECIAL TOOL STEEL

These are special alloy tool steels which after heat treating attain the greatest hardness of any type of tool steel, not excepting high speed and self hardening steels. The composition and manufacture of these steels result in an extremely fine grain which enables them to develop and retain a very keen cutting edge under the most severe conditions. They will make a good finishing cut which no other tool or high speed steel can equal. In addition to this extreme hardness, they also possess a very high degree of toughness.

Double Special Tool Steel should not be run at high speeds and attempts to use them as high speed steel will result in failure. This type of steel is not suitable for tools subject to shocks, such as hammer and sledge blows. We recommend this grade for cutting extremely hard metals, such as chilled iron, high carbon steels, heat treated alloy steels and gun barrels; also for tough and stringy metals, like copper, brass, bronze, aluminum and its alloys. It may be safely hardened in intricate forms which permits of its use for tools for rifling and reaming gun barrels, taps, milling and form cutters, hobs and tools for automatic and screw machine work. It should be remembered that no metal which can be machined at all can resist a cutting tool made from Double Special Tool Steel, particularly when a fine finish cut is desired. For automatic screw machines, taps, insert reamer blades and similar purposes, we supply at a moderate advance in price, cold drawn Double Special Tool Steel in sizes as required. Large stocks of standard sizes in the annealed condition are carried at our Mills and Branches.

Prices are subject to High Speed Steel Classification of Extras, as shown on pages 24–25.

SUGGESTIONS FOR TREATMENT OF DOUBLE SPECIAL TOOL STEEL

For forging, heat thoroughly to about 1800° F. Greater toughness and refinement of grain in the finished tool can be obtained by finishing forging at 1400° to 1500° F. Heavy blows below a medium red heat are likely to result in forging strains and cracks.

For hardening, preheat to a temperature between 1250° and 1300° F. Transfer to a higher temperature furnace and heat to a temperature between 1550° and 1650° F. and quench in water or brine. The exact temperature and quenching medium will depend somewhat on the size and shape of the tool. Very small tools may be hardened in oil. Do not soak at the high heat but quench as soon as the tool has reached a uniform temperature. Remove from quenching bath as soon as ebullition ceases and do not allow to remain in the water until cold. Draw the temper, as soon as possible, after removing from the quenching bath, to 350° F. or higher, depending upon the nature of the tool and the work it is to perform. Ordinarily, it is only necessary to draw to relieve strains and below a point where temper colors appear.

CHAMPION DOUBLE SPECIAL TOOL STEEL

This type of Double Special Steel was developed for use in our own Ordnance Department for tools used in connection with high explosive and armor piercing shells, for rifling gun tubes and boring Monel Metal periscope tubes. In general, it is suitable for the same purposes as the Double Special Steels previously described.

Prices are subject to High Speed Steel Classification of Extras, as shown on pages 24–25.

RECOMMENDED HEAT TREATMENT

For forging, heat thoroughly to about 1800° F. and the forging should not be continued below 1400° to 1450° F. Reheat, if necessary, to maintain a proper finish forging temperature. Harden in water or brine from 1550° to 1650° F. depending upon the size and shape of the tool. Draw the temper slightly to relieve strains but not to the point where temper colors appear.

CHAMPION SPECIAL TOOL STEEL

This grade, which is properly classed with the Double Specials, differs from them in that it is capable of hardening in oil in fairly large sections. It is a deeper hardening steel than Sanderson or Crescent Double Special. Its oil hardening properties make it useful for such tools as long broaches, taps and reamers and other tools where there is danger of warping in a steel which must necessarily be hardened in water or brine. This steel is particularly adapted to tools which are subjected to abrasion, such as deep drawing dies and punches, blanking dies and similar tools.

Prices are subject to High Speed Steel Classification of Extras, as shown on pages 24–25.

RECOMMENDED HEAT TREATMENT

Forging—the same as Double Special. Water or brine quenching is recommended for tools the design of which render warping unlikely. Quench from a temperature of 1525° to 1625° F., depending upon the shape and size of the piece. Where a greater depth of hardness is desired the hardening temperature used should be near the upper end of the range. For oil hardening, quench from a temperature of 1650° to 1750° F., depending upon the size and shape. The temper should be drawn slightly to relieve strains, usually not over 390° F. Where the maximum hardness is not required, the drawing temperature can be adapted to the nature of the work to be performed.

H.Y.C.C. STEEL

This alloy tool steel is of particular value to resist abrasive wear, as in forming and crimping rolls, perforating dies, plug gauges, forming tools for shaping or deep drawing steel or other metals, thread rolling dies and wire drawing dies. It is both an air-hardening and oil-hardening steel and its resistance to softening is so great that a drawing temperature of 700° F. leaves the steel file hard. In hardening, this steel undergoes very little distortion or warping. It hardens to great depth which permits frequent grinding in tools without decreasing their efficiency.

Prices are subject to High Speed Classification of Extras, as shown on pages 24–25.

RECOMMENDED HEAT TREATMENT FOR H. Y. C. C. STEEL

For forging, heat slowly and uniformly to 1750/1850° F. Reheat if necessary to complete the forging if the temperature falls below 1600° F. After forging allow to cool very slowly and—preferably—after the tool has cooled—give it a normalizing treatment by reheating to about 1800° F. followed by moderately slow air cooling.

To anneal, heat slowly and uniformly to 1500/1600° F. followed by very slow cooling, preferably in the furnace.

For hardening, heat slowly and uniformly to 1650/1750° F. depending upon the size and shape of the tool, followed by quenching in oil or air. If air-hardening is to be used, the quenching temperature may be a little higher than for oil quenching. The steel should be held at the hardening temperature for about ten minutes to permit of the maximum solution of carbides. In general, alloy steels require greater time at the hardening heat than is necessary in hardening carbon tool steels.

OIL HARDENING TOOL STEELS

PARAGON OIL HARDENING TOOL STEEL
CHAMPION NON-CHANGEABLE TOOL STEEL

In these steels we have successfully combined the property of deep hardening, refinement of grain, keen cutting and freedom from the tendency to distortion and change of dimensions so difficult to control in the regular Carbon Tool Steels.

Due to the fact that they harden thoroughly in oil and retain their dimensions, complicated sections, tools and hardened parts, where accuracy of dimensions is essential, can be successfully made from these steels. Dies and tools of such construction as prohibited grinding to shape after hardening are successfully made of these oil hardening steels.

These steels have been found to be highly successful in a wide field of use, and are especially recommended for tools such as

Taps	Reamers
Broaches	Test Plugs
Gauges	Thread Rolling Dies
Master Tools	Hobs
Stamping and Blanking Dies	and other form tools.

A large variety of standard sizes in the annealed condition is carried in stock at our various Branches.

The price of Oil Hardening Tool Steel is subject to Carbon Tool Steel Classification of Extras, as shown on pages 64-65.

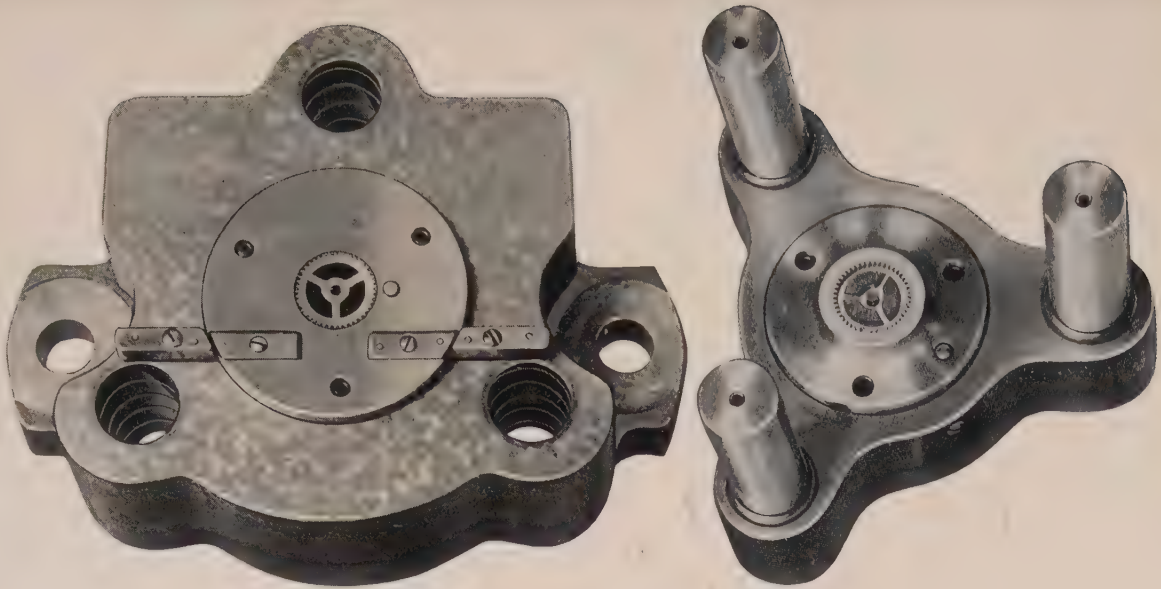
SUGGESTIONS FOR TREATMENT OF OIL HARDENING TOOL STEEL

FORGING:—Forge at about 1950° F. Forging should not be carried below 1400° F.

HARDENING:—Heat slowly to about 1450° to 1550° F., depending upon the shape and mass of the piece to be hardened, allowing more time than for ordinary tool steel to permit of complete solution of the carbides.

Quench in thin, warm oil until the piece has reached the temperature of the bath. Draw as soon thereafter as practicable. Violent lateral motion of the piece in the quenching bath is likely to result in needless distortion.

DRAWING:—For most cutting tools and gauges draw from 300° to 325° F. This is sufficient to remove strains. For dies or punches draw to temperatures from 325° to 475° F., depending on the relative degree of toughness or hardness desired.



Punch and die for blanking out brass into small gears to variation of .0005. These parts show no sign of wear after blanking several million pieces. Made from our oil hardening steel.

CHAMPION EXTRA TOOL STEEL

This Alloy Steel possesses all the properties of the best grades of carbon tool steel, but due to its alloy content, many of these properties are developed to a much greater degree than is possible in a carbon steel; for example, one which is of major importance—*endurance*. It has also some properties which carbon tool steels do not possess such as depth of hardness penetration without the sacrifice of strength. In the annealed condition it is as easily machined as carbon steel and in both the annealed and treated condition it has a grain refinement such as cannot be obtained with carbon steel. This advantage should be of paramount interest to the tool-maker and user. The *change of size* in hardening is much less than with carbon or other types of water or brine hardening tool steels and this feature is not greatly affected by the time element as is the case with other tool steels.

To the user the combination of the properties found in Champion Extra have a special significance. Champion Extra will be found suitable for all tools where it has been customary to use high-grade carbon steel, and due to its greater endurance will be found more economical. It is recommended for cutters, reamers, taps, threading dies, hobs, punches and blanking dies, deep drawing tools, shear blades, etc. Its use is not confined exclusively to cold working tools, for its property of deep hardening and its resistance to softening by drawing allow it to operate to much better advantage, in hot working operations, than carbon steel.

CAUTION:—Champion Extra, when furnished for hot working tools, is made in a lower temper than is appropriate for cold working tools. When ordering steel for "hot work" the order should so specify.

Prices are subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

INSTRUCTIONS FOR HARDENING

Quench in cold water or brine from a temperature of 1480° to 1580° F., the temperature used being regulated by the size and shape of the piece, also the depth of hardness desired. The fact that this is an alloy steel necessitates longer holding at heat than for a straight carbon steel. If the tool is heated in lead or salt bath, the minimum temperature should be not less than 1520° F.

DRAWING:—As a rule the same drawing temperatures that have been found suitable for carbon steel will be suitable for a corresponding piece made from Champion Extra.

FOR HOT WORKING TOOLS:—The drawing may be accomplished from 550° to 800° F., depending on conditions under which the tool is to operate.

CRESCENT HOT WORK No. 2 STEEL
PARK "SB" STEEL

These are alloy steels intended primarily for tools to be used on Hot Work, such as Gripper Dies and Header Dies in Rivet and Bolt forging machines, in Pneumatic and Hydraulic or other riveting machines, Shearing and Cutting Off Tools and Hot Pressed Nut Dies. They are also well adapted for Hot Forging Mandrels, such as Swaging Mandrels used in making Hollow Forgings, or other forms of mandrels for hot work. Excellent Hot Piercing Punches may be made of these steels.

When these steels are used for Mandrels or Piercers in Hot Work and the temperature of the material being worked heats the tool to a visible red, it is best practice to permit the tool to cool naturally in the air. Do not quench in water or other liquids. Crescent Hot Work No. 2 and Park "SB" Steel are Alloy Steels of great density and should never be subjected to the shock of sudden cooling, unless the tool has been uniformly heated. For this reason it is usually found advantageous to have two or more mandrels or piercers of each kind, so that while one is in service the others, which have previously been used, may be cooling.

These two grades of steel are furnished either in the annealed condition (for machining and subsequent hardening) or heat treated for use without further hardening.

Prices are subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

HARDENING

Two general methods have been found effective:

METHOD I.—Heat the tools slowly, thoroughly and uniformly to between 1800° and 1850° F., or slightly higher, then remove from the furnace and cool naturally, or in a mild blast of dry air. After the tools are thoroughly cooled, the temper may be drawn at various heats, depending on the purpose, up to about 1000° F. Cool naturally.

METHOD II.—Heat the tools slowly, thoroughly and uniformly to 1700° F. (bright red). After the tools have been brought to the required temperature remove from the fire and cool by quenching in thin oil. The best results will be obtained if the oil is first warmed

to 100° or 125° F. The tools should be left in the oil until they are cooled sufficiently so that the oil will no longer "flash" on the surface of the tool if it is lifted out of the bath. Then place the tool in a tempering furnace, which has previously been heated to about 1000° F. After the oil has "flashed" or burned from the surface of the tool, rub it slightly with an emery stick, so that the color of the oxide may be seen. The tool should be removed from the furnace when the oxide shows a full blue or green color, and then be cooled naturally in the air. Tools hardened in this manner should show the same hardness value as those hardened by the first method.

ATHA "PNEU" STEEL
CRESCENT ALLOY CHISEL STEEL

These are Alloy Tool Steels for both Cold Work and Hot Work. They were developed to combine a high degree of cutting hardness with great strength and toughness. We recommend them as being particularly valuable for the following uses:

COLD WORK:—All classes of battering tools, especially those used in pneumatic machines, such as chipping chisels, beading tools, calking tools, rivet busters, backing-out punches and other boiler-makers' tools, cold sets, swages, track chisels, etc.

HOT WORK:—These steels possess a marked degree of Red Hardness which makes them suitable for a large number of operations on hot metal. They have proven valuable for the following: Hot cutters, shear blades, punches, dies, hot sets, heading and forming tools, dollies and other tools for sharpening quarry and mine drills.

A stock of standard sizes is carried at our Branches.

Prices are subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

ANNEALING

Heat slowly and thoroughly to 1400/1450° F. Follow by slow cooling.

FORGING

Heat slowly to a uniform heat of from 1800° to 2000° F. (a light salmon to a yellow heat). The piece should remain at this heat for sufficient time to insure a thorough and uniform penetration. As these are Alloy Steels this operation will necessarily consume more time than the same operation on a straight carbon steel. The piece may then be worked until a temperature has been reached of about 1500° F. or a bright red, but no lower. If further forging is necessary the piece should be reheated.

The durability of the tool is greatly increased if, after forging and before grinding, the entire tool is heated to about 1500° to 1600° F. (full red to a dark orange) and allowed to cool naturally in the air.

HARDENING

These steels can be hardened in oil, water and air. Oil hardening is recommended as the best for general work. This has the advantage of minimizing danger of cracking, and in addition to this the range of hardening is wider than with water. No more of the point or working face should be heated for hardening than is necessary to accomplish the desired results when treating tools with sharp points, sharp sections, or generally speaking of small face or area.

OIL HARDENING:—Heat slowly and thoroughly to a temperature of from 1650° to 1800° F. (light red to bright orange), and quench in oil. Tools for hot work should be hardened by heating to 1700/1850° F. and quenched in oil.

WATER HARDENING:—Heat slowly and thoroughly to a temperature of 1550° to 1650° F. and quench in water. Be careful not to exceed the latter temperature.

AIR HARDENING:—Heat to between 1800° and 1900° F. and cool in a strong, dry air blast. Air hardening is not suitable for tools of heavy section.

When properly hardened, cold metal working tools should be so that they can be just "touched" with a sharp file.

Tools which have to cut stone, brick, concrete or other similar materials should be heated rapidly to about 2000° F. (yellow) and quenched in oil. This will make them "file proof." Heat like high speed steel—that is to say, preheat slowly to moderate temperature and then raise to the final temperature quickly. Steels must not be soaked at high heat. These steels are very dense in nature and considerably more time must be allowed for heating than is necessary for carbon steels.

DRAWING:—For Cold Work Tools, draw at 400° to 500° F. This temperature produces toughness with little loss of original hardness. Higher temperatures up to 1000° F. can be used on Hot Work Tools where extreme hardness is not essential. The drawing for Hot Work Tools may be varied according to the purpose; at 1100° F. drawing temperature, the hardness will be above 400 Brinell or 60 Shore.

PRECAUTION:—When ordering these steels for Hot Work the order should so specify.

VIKING SPECIAL TOOL STEEL
VIKING EXTRA TOOL STEEL

These steels have much better cutting qualities, greater endurance, and hold their size in hardening better than carbon tool steels. They are now used extensively in the manufacture of twist drills, cutting and blanking dies, staybolt taps and punches, reamers, milling cutters, threading tools, lathe, planer and shaper tools, special knives and shear blades. They are furnished in suitable tempers to meet various requirements.

Prices subject to Carbon Tool Steel Classification of Extras, as shown on pages 64-65.

HARDENING:—Heat from 1460° to 1560° F. and quench in cold water or brine.

DRAWING:—Draw at a temperature of 325° to 550° F., depending on the hardness required. Hot Work Tools may be drawn from 550° to 800° F., depending on conditions under which the tools have to operate.

ALVA SPECIAL ALLOY TOOL STEEL
ALVA EXTRA ALLOY TOOL STEEL

These are high grade Alloy Tool Steels, prepared especially to meet conditions where great strength and toughness are essential features. They are particularly adapted to the following purposes: Blanking, Forming and Threading Dies, Taps, Reamers, Punches, Edge Tools and Shear Blades. In the milder tempers they are excellent for Pneumatic Rivet Sets, Chisels, Calking Tools, Hammers, Mining Tools, Beading Tools, Stone Tools and Flue Rollers; also for special High Duty Shafts and similar purposes where a glass hard surface combined with a hard but tough and strong core is desired. These steels combine a maximum degree of toughness and hardness with high resistance to fatigue.

Above steels are furnished in proper tempers for various purposes; standard sizes are carried in stock at Branch Warehouses.

Prices subject to Carbon Tool Steel Classification of Extras, as shown on pages 64-65.

SUGGESTIONS FOR HARDENING

Quench from 1460° to 1520° F. in cold water or brine and draw at approximately 450° F. These heats and the time element involved can be adjusted to meet the requirements of the various purposes

outlined above so as to secure the best results in various sizes, shapes and design of tools. When heated in lead, a temperature not below 1500° F. is recommended.

CRESCENT RIM ROLL STEEL
ATHA RIM ROLL STEEL

Rim Rolls, as the name signifies, are rolls used in rolling to finished shapes and sizes, rims which hold tires on automobile wheels. We have developed and recommend for this purpose the above grades which are being used with very satisfactory results.

These steels are also suitable for rolls used in rolling Felloe Bands.

In addition, we recommend these brands for Drawing Dies or Rings for drawing Brake Drums.

TREATMENT

FOR RIM ROLLS:—After machining normalize by heating to 1400° F.; cool naturally in air. Reheat to 1475° F.; quench in clear cold water or salt brine and draw temper to 375° F. If the rolls contain very deep grooves, the hardening temperature may be raised to 1500° F.

FOR DRAWING DIES:—After machining put in cold furnace and heat slowly to 1400/1450° F.; shut off heat and leave in furnace until cold. Reheat to 1450/1500° F. (depending on size) and let dies soak thoroughly. Quench in cold water or brine until they have reached temperature of about 300° F. then transfer to warm oil bath and leave until cold. Transfer to tempering bath which has been heated to 100° F., and slowly raise heat to 375°/425° F. at which temperature the dies should be held for thorough and even drawing, holding at heat for two to three hours in the larger sizes.

TRIPLE ALLOY PUNCH STEEL

This Alloy Tool Steel has been developed for Cold Work Tools requiring exceptional resistance to fatigue or endurance combined with maximum toughness and dynamic strength. These properties give increased life to tools which are subject to unusual shock or stress.

Triple Alloy Steel has given unusual service and is especially recommended for Cold Punching Tie Plates and Structural Steel of great thickness. It is also well adapted for many other purposes of this character.

Punches ¾" square, of Triple Alloy Steel, have given from 4000 to 5000 holes before requiring redressing, when cold punching railroad tie plates through the shoulder where the metal is 1⅛ inch

thick. Individual punches of this material have punched from 40,000 to 60,000 holes through $^3/_4$" thick plates.

Price of Triple Alloy Punch Steel is subject to Carbon Tool Steel Classification of Extras, as shown on pages 64-65.

SUGGESTIONS FOR TREATMENT

Harden in water from 1550° to 1600° F. and draw at about 450° to 500° F.

While Triple Alloy Steel Punches can be tempered on a hot plate, a more economical method is to draw the punches all over in oil. This not only cuts down the time required for tempering, but brings out more satisfactorily the inherent qualities of Triple Alloy Punch Steel. In this steel it is not necessary to separately draw the temper of the punch-end and the shank. Tempering uniformly all over not only saves time, but increases production. For heavy duty punches it is desirable to leave the punch in the drawing bath several hours.

PARK No. 183 STEEL

This is an alloy steel which possesses the property of holding a very keen edge coupled with unusual toughness. It is particularly useful for veneer knives and for cutting dies for paper, tobacco, etc. It has also been found very useful for heavy duty punches. This steel may be hardened in water or oil.

Prices are subject to Carbon Tool Steel Classification of Extras, as shown on pages 64-65.

RECOMMENDED HEAT TREATMENT

For moderately small sections, either water or oil may be used. If hardened in oil, heat to a temperature between 1430° and 1480° F.—for water hardening, a temperature between 1375° and 1450° F. The steel thus hardened will show a very fine fracture but it is also true that the fracture is not materially coarsened even at a hardening temperature as high as 1550° F. This wide safe hardening range is a distinct advantage in treatment in places where facilities for accurate control are not ideal. Accurate work at a definite temperature is always better than un-uniform heating notwithstanding the steel may inherently possess a wide hardening range. The temper may be drawn to 400° F. in the oil hardened steel, or 450° F. in the water hardened steel without material decrease in hardness but with a material increase in toughness. For punches, it has been found that a long time at the drawing temperature gives improved results. The time and extent of the drawing, however, may be regulated according to the purpose for which the steel is to be used.

SCALE PIVOT STEEL

Special Alloy Scale Pivot and Knife Edge Steel

This grade is particularly adapted to heavy duty scales, such as those used by railroads and by steel mills in weighing heavy ladle cars. It possesses to a marked degree the essential characteristic of hardness, combined with toughness, and, by reason of its great resistance to breakage and crumbling, has become the best known steel for Scale Pivots and Knife Edges in heavy scales. In fact, a Special Scale Committee of Railway Officials which was engaged for several years in the work of determining the grade of steel best adapted for such parts in railway track scales gave its decision in favor of our grade known as SPECIAL ALLOY SCALE PIVOT AND KNIFE EDGE STEEL, by which name it is being specified by many of the leading railroads.

CRUCIBLE SCALE PIVOT AND KNIFE EDGE STEEL

This steel is a standard product which has been used extensively for years by well known scale manufacturers all over this country.

Both of the above grades are subject to the following classification of sizes and extras:

BASE SIZES—PIVOT SHAPE

No. OE	No. 1E	No. 2E	No. 3E	No. 4E
$1\frac{1}{2}$x$1\frac{1}{8}$ in.	$1\frac{5}{16}$x1 in.	$1\frac{7}{32}$x$\frac{7}{8}$ in.	$1\frac{1}{16}$x$\frac{3}{4}$ in.	$\frac{53}{64}$x$\frac{39}{64}$ in.

No. 6	No. 7	No. 7½	No. 8	No. 9
$\frac{27}{64}$x$\frac{5}{16}$ in.	$\frac{33}{64}$x$\frac{3}{8}$ in.	$\frac{35}{64}$x$\frac{13}{32}$ in.	$\frac{19}{32}$x$\frac{7}{16}$ in.	$\frac{5}{8}$x$\frac{15}{32}$ in.

No. 10	No. 11	No. 12	No. 13
$\frac{43}{64}$x$\frac{31}{64}$ in.	$\frac{47}{64}$x$\frac{17}{32}$ in.	$\frac{15}{16}$x$\frac{11}{16}$ in.	$1\frac{1}{32}$x$\frac{13}{16}$ in.

EXTRA SIZES—PIVOT SHAPES

No. 1	No. 2	No. 3	No. 4	No. 5
$\frac{11}{64}$x$\frac{1}{8}$ in.	$\frac{1}{4}$x$\frac{3}{16}$ in.	$\frac{19}{64}$x$\frac{15}{64}$ in.	$\frac{21}{64}$x$\frac{1}{4}$ in.	$\frac{3}{8}$x$\frac{9}{32}$ in.
Extra per lb., Cents.				
40	20	5	2	2

CRUCIBLE MELTING FURNACES

CARBON TOOL STEEL

CARBON TOOL STEEL

SPECIAL GRADES

PARK SPECIAL TOOL STEEL
CRESCENT SPECIAL TOOL STEEL
SANDERSON SPECIAL TOOL STEEL
LA BELLE SPECIAL TOOL STEEL
HOWE SPECIAL TOOL STEEL
ATHA SPECIAL TOOL STEEL

Special Tool Steel is our leading brand of high duty straight carbon tempering steel. It finds a wide field of usefulness in all kinds of tools and dies where great toughness combined with the best wearing qualities is required.

It is the steel par excellence for general high grade work where service is the first consideration and initial cost of the steel secondary. It hardens in water or brine at a low heat and has a wide factor of safety.

Special Tool Steel can be used with the greatest confidence for expensive tools and dies of intricate design. We strongly recommend it for a general shop steel and an almost unlimited number of purposes. Among these may be mentioned:

Punches and Dies	Drills
Cutters	Forming Tools
Taps	Threading Dies
Reamers	Turning, Planing and Slotting Tools
Broaches	Stamping and Engraved Dies
Augers	Shear and Tobacco Knives

Mandrels

It is made in all tempers. It can be furnished annealed or unannealed as desired. A large stock of standard sizes is carried at our Branches, in rounds, squares, flats, discs and die blocks.

Special Tool Steel is subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

CARBON TOOL STEEL

EXTRA GRADES

PARK SILVER TOOL STEEL
CRESCENT EXTRA TOOL STEEL
SANDERSON EXTRA TOOL STEEL
SANDERSON PEERLESS EXTRA TOOL STEEL
LA BELLE EXTRA (PREMIER) TOOL STEEL
HOWE EXTRA TOOL STEEL
ATHA EXTRA TOOL STEEL

Extra Tool Steel is an intermediate grade of straight carbon tool steel appealing strongly to any one requiring a dependable steel. To those who are disinclined to pay the difference in price commanded by Special Tool Steel, or where the work is not severe enough to warrant the use of the higher grade, we strongly recommend our Extra Grade with assurance that in these circumstances it will render a full measure of satisfactory service. It gives excellent results for

Threading Dies	Cold Chisels
Dies for Hot and Cold Work	Cold Sets
Milling Cutters	Cold Cutters
Boiler Maker's Snaps	Edge Tools
Taps	Shear Knives
Granite Points	Wood Working Tools

and various other uses.

It is made in all tempers. Large stocks of standard sizes in both annealed and unannealed condition are carried at our Branches.

Extra Tool Steel is subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

CARBON TOOL STEEL

STANDARD GRADES

BLACK DIAMOND (PARK) TOOL STEEL
CRESCENT TOOL STEEL
SANDERSON STANDARD TOOL STEEL
LA BELLE (EAGLE) TOOL STEEL
ATHA CHAMPION TOOL STEEL
HOWE TOOL STEEL

For fifty years or more our various brands of Standard Tool Steel have been favorites in the factory, at the forge, in the machine shop, and in quarry, mine and field, where drills, hammers, sledges and general blacksmithing tools possessing good wearing qualities are required.

"Always dependable" is the verdict which has come down through the long years during which these steels have served so well. The higher grades, such as Special and Extra, should be given the preference where the work is exacting and long continued. But for ordinary purposes, experience well supports the widely current belief that there are no better steels obtainable at the price than our various brands of Standard Tool Steel.

They machine with ease, forge readily and offer no difficulties in hardening. They are made in all tempers. Large stocks of standard sizes of rounds, squares, octagons and flats are carried at our various Branches.

Prices subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

CONE STEEL

Cone Steel is Standard Tool Quality, soft annealed, for use in automatic machines. Bars are straight and true to size and permit highest production on automatics. It is a safe steel to harden and is extremely tough and reliable.

Prices subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

PYROMETERS

In heat treating Tool and all High Grade Steels, the use of pyrometers is increasing constantly. We recommend the installation and constant use of such equipment, wherever possible. Accuracy and uniformity in the finished article depends upon uniformity of working conditions and a most important factor is to have every tool or piece of the same kind and shape heated uniformly and thoroughly after the proper degree of temperature is determined.

It is important that the heat in the furnace as recorded by the pyrometer be uniformly communicated to the steel. The position of the terminal of the pyrometer as located in the furnace with reference to the article being treated is a very important feature for, if not properly located, it will register a different temperature from the article being treated.

Pyrometers must therefore be checked frequently for accuracy and used with good judgment. For checking, we suggest a standard Portable Pyrometer be reserved for test purposes only. In use, the fire end is placed side by side with the fire end to be checked, bringing the hot junction of the Standard Pyrometer as close as possible to the hot junction being tested. Should the operator wish to check his Standard Pyrometer, this can be done by the use of metals and salts, the melting points of which have been determined by the Bureau of Standards. Information concerning this method can be obtained from them on application.

HEAT TREATMENT OF CARBON TOOL STEELS

If an expensive tool or die is to be made, it is good practice to make a preliminary hardening test on a piece cut from the same bar. Quench this test piece from what is considered the proper temperature and break the hardened specimen so as to get a clean fracture. If it shows a fine silky grain, hard to file, the correct hardening heat has been used. If the grain is a trifle fibrous and stringy, and not extremely hard, the heat is too low. If the fracture is coarse or "stony" in appearance, too high a heat has been used and the temperature should be lowered. In case rehardening is required, always reheat the sample to a dark red and allow it to cool so as to relieve all strains induced from previous hardening. Then quench from a temperature 15° higher or lower than the first trial, as the case may be.

In factories where tools such as drills, cutters, reamers and taps are hardened in large quantities, a schedule should be prepared showing every size of tool, its correct hardening temperature and prescribed length of time for heating. The nearer the hardener approaches these accurate conditions, the longer the life of the tools and the more uniform his product.

Where a miscellaneous line of shop tools is hardened, a record of the temperature and the length of time given to the heating as well as the drawing temperature, should be preserved. The hardener should receive reports of the performance of the tools with such frequency as will enable him to determine if his hardening methods are correct. With steels so uniform and carefully made as are our Carbon Steel brands, the best tools can be made and duplicated indefinitely providing a careful hardener, supplied with the proper equipment and information, has charge of the work.

In small blacksmith shops, where only an open fire is available, care should be taken that the steel is not exposed to flame or blast, for this results in too rapid heating, heavy scaling or decarbonization and burning of the tool. See that the fuel is well coked and that there is a good, deep body of fire before inserting the steel that is to be forged or hardened. Use a gentle blast and do not rush the work to such an extent that the corners or points of the tool become overheated. In other words, strive to duplicate the even, gentle heating of a furnace fire. Tool Steel is relatively high in carbon, and this carbon is easily burned out or oxidized on the surface by the oxygen present in the air blast. If the carbon, or even part of it, is thus burned out, the steel acts on the surface like lower carbon steel, and will not harden properly on the surface.

SUGGESTIONS FOR WORKING AND TREATING OUR CARBON TOOL STEELS

FORGING:—Our Carbon Tool Steels are made in a full range of carbon tempers from about 0.50 to 1.50 per cent. The correct forging heat for any temper will depend on the percentage of carbon, the size of the piece, and the amount of reduction necessary in the forging operation. Generally speaking, the heats would vary from about 1500° to 1950° F., the higher heats being used for the lower carbons or for the larger forgings requiring considerable work, and the lower heats for the higher carbons or such pieces as require only a small amount of work. In any case, as the forging approaches the

final stages, the hammering should become more rapid with lighter blows so as to finish the work at a dark red heat, refining the grain and leaving the steel in a better condition for either annealing or hardening.

After drop forging we recommend normalizing the pieces by heating to 1600/1650° F. and allowing to cool in air.

CAUTION:—Do not hold at the maximum temperature for an extended period.

ANNEALING:—It is well to purchase annealed bars. Our Mills have the most modern equipment for annealing. Furthermore, from our long experience we are better prepared to do the annealing than the ordinary Blacksmith Shop or Hardening Room. Only a nominal charge is made.

It is often necessary, however, for the Blacksmith or Hardener to anneal tools or forgings to relieve strains, and to put them in condition for machining or reworking. Such annealing can be done most uniformly if the steel is packed in a pipe or box of dimensions sufficient to allow room for one inch or more of fine dry lime or mica chips between the parts and the sides of the box—this is to exclude the air and prevent oxidation and decarbonization.

ANNEALING:—Heat to 1350/1450° F. and after being thoroughly heated at this temperature, hold for two to four hours. Then cool the metal as slowly as possible—overnight in the furnace is a good way. Do not expose to the air until cold. If it is necessary to use the furnace again immediately remove the box and cover it with a heap of fine dry lime, ashes, mica chips or some other non-conductor of heat that will help the steel to cool slowly.

HARDENING:—For hardening our Carbon Tool Steels, only the usual precautions are necessary.

Between 1400° and 1500° F. is the range of heats at which all the brands of our Carbon Tool Steels will harden satisfactorily. It is only rarely that a heat slightly below 1400° F. should be used and this on the smallest and thinnest pieces. It is necessary to exceed 1500° F. only when hardening an extremely large or bulky tool. Therefore, it is safe to say that for the great majority of tools of ordinary size and shape 1425° to 1475° F. are the two limits of hardening heat.

Every shop that uses Tool Steel in any quantity, is, or ought to be, provided with a practical, up-to-date hardening equipment.

The furnace should be so built as to protect the steel from undue oxidation. The tools should not be heated too long, because a soak-

ing heat, or too high a heat, coarsens the grain and takes away the inherent strength that is necessary to prevent cracking in hardening. Each piece of steel to be hardened should be carefully heated throughout, without allowing any part of the work to become appreciably hotter than the other. This means, bring to heat rather slowly.

QUENCH in water, or brine or oil depending on hardness required.

DRAWING:—Successful drawing may be done either in a furnace or in a bath of molten salt or hot oil. When drawing the temper, do not have either the furnace or the bath hotter than the required temperature; also be sure that the piece is left in long enough to be heated uniformly to the core. The drawing range is from 350° to 600° F., depending on hardness required.

CARBON TOOL STEEL

Standard Classification of Extras

All Dimensions Inclusive

Intermediate sizes take the next higher extra

BASE SIZES

ROUND, SQUARE AND OCTAGON

$\frac{5}{8}$ inch to 2 inches, inclusive

EXTRA SIZES

ROUND, SQUARE AND OCTAGON

Inches	Extra per Lb. Cents
$\frac{5}{8}$ to 2	Base
$2\frac{1}{8}$ to 3	1.0
$3\frac{1}{8}$ to 4	1.5
$4\frac{1}{8}$ to 5	2.0
$5\frac{1}{8}$ to 6	2.5
$6\frac{1}{8}$ to 7	3.0
$7\frac{1}{8}$ to 8	3.5
$\frac{9}{16}$ to $\frac{1}{2}$	0.5
$\frac{7}{16}$ to $\frac{3}{8}$	1.0
$\frac{5}{16}$ and $\frac{11}{32}$	2.0
$\frac{1}{4}$ and $\frac{9}{32}$	3.0
$\frac{3}{16}$	5.0
$\frac{5}{32}$	10.0
$\frac{1}{8}$	18.0

Annealing ..... 1c. per lb. extra

CARBON TOOL STEEL

Standard Classification of Extras

All Dimensions Inclusive

Intermediate sizes take the next higher extra

BASE SIZES

FLAT

$\frac{9}{16}$ Inch to 2 Inches Thick x $\frac{5}{8}$ Inch to 2 Inches Wide

EXTRA SIZES

FLAT

Inches	Extra per Lb. Cents	Inches	Extra per Lb. Cents
$\frac{1}{8}$ x $\frac{3}{16}$	20.0	$\frac{5}{16}$ x $\frac{3}{8}$ to $\frac{5}{8}$	1.5
$\frac{1}{8}$ x $\frac{1}{4}$	15.0	$\frac{5}{16}$ x $\frac{11}{16}$ to 8	1.0
$\frac{1}{8}$ x $\frac{5}{16}$	8.0	$\frac{3}{8}$ x $\frac{7}{16}$ to 8	1.0
$\frac{1}{8}$ x $\frac{3}{8}$	4.0	$\frac{7}{16}$ x $\frac{1}{2}$ to 8	1.0
$\frac{1}{8}$ x $\frac{7}{16}$ to $\frac{1}{2}$	3.0	$\frac{1}{2}$ x $\frac{9}{16}$ to 8	1.0
$\frac{1}{8}$ x $\frac{9}{16}$ to 7	2.0	$\frac{9}{16}$ x $2\frac{1}{8}$ to 8	1.0
$\frac{1}{8}$ x $7\frac{1}{8}$ to 8	3.0	$\frac{9}{16}$ to 2 x $\frac{5}{8}$ to 2	0.0
$\frac{3}{16}$ x $\frac{1}{4}$	5.0	$\frac{5}{8}$ to 2 x $2\frac{1}{8}$ to 7	1.0
$\frac{3}{16}$ x $\frac{5}{16}$	4.0	$\frac{5}{8}$ to $1\frac{3}{4}$ x $7\frac{1}{8}$ to 8	1.0
$\frac{3}{16}$ x $\frac{3}{8}$	3.0	$1\frac{7}{8}$ to 2 x $7\frac{1}{8}$ to 8	1.5
$\frac{3}{16}$ x $\frac{7}{16}$ to $\frac{5}{8}$	2.0	$2\frac{1}{8}$ to 3 x $2\frac{1}{8}$ to 5	1.0
$\frac{3}{16}$ x $\frac{11}{16}$ to 2	1.5	$2\frac{1}{8}$ to 3 x $5\frac{1}{8}$ to 8	1.5
$\frac{3}{16}$ x $2\frac{1}{8}$ to 7	1.0	$3\frac{1}{8}$ to 4 x $3\frac{1}{8}$ to 6	1.5
$\frac{3}{16}$ x $7\frac{1}{8}$ to 8	2.0	$3\frac{1}{8}$ to 4 x $6\frac{1}{8}$ to 8	2.0
$\frac{1}{4}$ x $\frac{5}{16}$ to $\frac{3}{8}$	2.0	$4\frac{1}{8}$ to 5 x $4\frac{1}{8}$ to 7	2.0
$\frac{1}{4}$ x $\frac{7}{16}$ to $\frac{5}{8}$	1.5	$4\frac{1}{8}$ to 5 x $7\frac{1}{8}$ to 8	2.5
$\frac{1}{4}$ x $\frac{11}{16}$ to 2	1.5	$5\frac{1}{8}$ to 6 x $5\frac{1}{8}$ to 8	2.5
$\frac{1}{4}$ x $2\frac{1}{8}$ to 7	1.0	$6\frac{1}{8}$ to 7 x $6\frac{1}{8}$ to 7	3.0
$\frac{1}{4}$ x $7\frac{1}{8}$ to 8	2.0	$6\frac{1}{8}$ to 8 x $7\frac{1}{8}$ to 8	3.5

Annealing ..... 1c. per lb. extra

Cutting to Specified Single and Multiple Lengths

24 inches to 18 feet	0.5	12 to 18 inches	1.5
18 to 24 inches	1.0	6 to 12 inches	2.0

Less than six inches, special price. Over 18 feet, special price.

PARK SPECIAL, SILVER AND BLACK DIAMOND TOOL STEEL

TEMPER CLASSIFICATION

A — Suitable for fine Files, such as Taper and other shapes, also for steel required in very hard wearing surfaces. Cannot be welded. Hardens at a very dark red. Hardening range approximately 1380° to 1430° F. depending on section.

C — Suitable for Tools for Cutting and Turning Chilled Castings, Stone Points (quarter octagon), Razors, Bush Hammers, Dental Tools, etc. Very difficult to weld. Hardens at dark red. Hardening range approximately 1380° to 1430° F. depending on section.

D — Suitable for Lathe, Planer and Slotter Tools for cutting very hard materials, Chilled Roll Turning Tools and Plugs, Razors, Gravers' Tools, Bush Hammers, Mill Picks, etc. Can be welded with great care. Hardens at dark red. Hardening range approximately 1380° to 1430° F. depending on section.

DX — Suitable for Lathe, Planer and Slotter Tools, Chilled Roll Turning Tools and Plugs, Boring Tools, Gravers' Tools, small Taps, Reamers, Dies, Milling Cutters, Forming Tools, Tube Drawing Dies, Brass Working Tools, Paper Knives, Leather Knives, Veneer Knives, etc. Can be welded with care. Hardens at dark red. Hardening range approximately 1400° to 1440° F. depending on section.

E — Suitable for Taps, Reamers, Milling Cutters, Nail Dies, Threading Dies, Brass-Working Tools, Bushings, Broaches, Cutting and Blanking Punches, and Dies. Cold Stamping Dies, Paper and Envelope Dies, Welded Planer and all Wood-Working Knives, Leather and Paper Knives, large Thrust and Ball Bearings, etc. A suitable temper for a great variety of shop uses. Weldable. Hardens at cherry red. Hardening range approximately 1400° to 1450° F. depending on section.

H — Suitable for Trimming Dies, small Punches and Dies, Leather Cutting Dies, small Chisels, Brass-Working Tools, Broaches, Cold Heading Dies, Mint Dies, small Shear Blades, Axes, Wood Bits, Hard Rock Drills, etc. Weldable. Hardens at cherry red. Hardening range approximately 1420° to 1460° F. depending on section.

L — Suitable for Punches and Dies, Shear Blades, Cold Heading Dies, Hand Chisels, large Trimming Dies, Pneumatic Chisels, small Hammer Dies, Rock Drills, Mining Drills, Well Drills, Nail Sets, Spring Bushings, etc. Welds with comparative ease. Hardens at cherry red. Hardening range approximately 1420° to 1480° F. depending on section.

M — Suitable for Rock Drills, Masons' Hammers, large Punches and Dies, Pneumatic and two-hand Chisels, large Shear Blades, Well Drills, etc. Welds easily. Hardens at cherry red. Hardening range approximately 1420° to 1480° F. depending on section.

N — Suitable for large Hammer Dies and Drop Forging Dies, very large Shear Blades, Well Drills, Rail Chisels, Cold Sets, Sledges, Hammers, Button Sets, Hot Bolt and Rivet Dies, Smiths' Tools, such as Flatters, Fullers, etc. Pneumatic Rivet Sets, Vise Jaws, etc. Welds easily. Hardens at bright cherry red. Hardening range approximately 1460° to 1540° F. depending on section.

O — Suitable for very large Hot Drop Forging Dies, and also in certain cases for Hand Snaps, Set and Cupping Tools and for Hot Work generally; Sledges, Hammers, Hot Sets, Smiths' Tools, such as Flatters, Fullers, etc. Welds easily. Hardens at bright red. Hardening range approximately 1460° to 1540° F. depending on section.

CRESCENT SPECIAL, EXTRA AND TOOL STEEL

TEMPER CLASSIFICATION

A-1 — For extremely hard work, such as turning hardened and tempered Gun Forgings, Chilled Rolls and all tools requiring extreme hardness. Hardens at a dark red heat. Hardening range approximately 1380° to 1430° F. depending on section.

A — For hard lathe work such as turning Chilled Rolls, Corrugating Tools, Drawing Dies, Gravers' Tools, Tube Mandrels, Razors, Hair Clippers and a great variety of other tools, when carefully handled. Hardens at a low red heat. Hardening range approximately 1380° to 1430° F. depending on section.

C — For general lathe work, Planer and Slotter Tools, Brass-Working Tools, Bush Hammers, Drawing Dies, Granite Points, Scale Pivots, Tube Mandrels, and many other tools and purposes. Hardens at a low red heat. Hardening range approximately 1380° to 1430° F. depending on section.

D — For Lathe, Planer, and Slotter Tools, Cold Stamping, Leather Cutting Dies, Glove Dies, Tube Mandrels, Jewelers' Dies, Cloth Dies, Nail Dies, Edge Tools, and a large number of other purposes. Hardens at a medium red heat. Hardening range approximately 1400° to 1440° F. depending on section.

E — For Jewelers' Rolls and Dies, Hard Rock Drills, Milling Cutters, Reamers, Threading Dies, Pocket Cutlery, Punches, Cup and Cone Steel, Twist Drills, Taps, Screw Dies, Mill Picks, Saws, Pene Hammers, Axes, Edge Tools, generally, and very many other purposes. Hardens at a medium red heat. Hardening range approximately 1420° to 1460° F. depending on section.

H&K — For Chisels, Gang Saws, Channeling Drills, Saw Swages, Threading Dies, Saws, Metal Drills, Mining Drills, etc. Hardens at a medium red heat. Hardening range approximately 1420° to 1460° F. depending on section.

L — Used largely for Mining Drills, Channeling Drills, Punches, Trimming Dies, Springs, Cold Chisels, Drifts, Saws, etc. Hardens at a medium red heat. Hardening range approximately 1420° to 1480° F. depending on section.

M — Mining Drills, Track Tools, Drop Dies, Chisels, Shear Knives, etc. Hardens at a bright red heat. Hardening range approximately 1420° to 1480° F. depending on section.

N — Shear Knives, Track Chisels, Hammer Dies, Forging Dies, Sledges, Cold Sets, Vise Jaws and numerous other tools. Hardens at a bright red heat. Hardening range approximately 1460° to 1540° F. depending on section.

O — Smith Shop Tools, Cupping Tools, Hot Sets, Set Screws, etc. Hardens at a good bright red heat. Hardening range approximately 1460° to 1540° F. depending on section.

P — For Hot Work generally, Bolt and Rivet Headers, Smith Shop Tools, Fullers, Hot Sets, Hot Drop Forging, Flatteners and many other purposes requiring a mild carbon steel. Hardens at a high bright red, almost into the yellow heat. Hardening range approximately 1480° to 1540° F. depending on section.

S — Crank Pins and Machinery Purposes, Hot Work when water is run on dies, Track Bolt Dies, etc. Hardens slightly at a yellow heat. Hardening range approximately 1480° to 1600° F. depending on section.

U — U-Bolts, Machine Drill Pistons and Chucks, Piston Rods, Monogram Dies and Engraver Plates. Will not harden.

LA BELLE SPECIAL, EXTRA AND TOOL STEEL

TEMPER CLASSIFICATION

No. 1½ For purposes where extreme hardness is required such as Chilled Roll Turning Tools, Roll Corrugating Tools, etc. Can be welded with great care. Harden at dark red. Approximate hardening range 1380° to 1430° F. depending on section.

No. 2 For Roll Turning Tools, Gravers' Tools, Drawing Dies, Granite Tools, Razors and other fine tools requiring great hardness. Can be welded with care. Harden at dark red. Approximate hardening range 1380° to 1430° F. depending on section.

No. 2½ Used generally for Lathe, Planer and Slotter Tools, for Brass-Working Tools, Drawing Dies, Threading Dies, Screw Dies, Razors, fine Files, such as Saw Files, etc. Can be welded with great care. Harden at dark red. Approximate hardening range 1400° to 1440° F. depending on section.

No. 3-X Will make the best Taps, Reamers, Threading Dies, Jewelers' Dies, Twist Drills, Ball Races, Milling Cutters, Engraving Dies, also for Trimming and Cutting Dies, Forming and Boring Tools, Drawing Dies, Mandrels, Granite Points and Edge Tools in general. Can be welded with care. Harden at dark cherry. Approximate hardening range 1400° to 1450° F. depending on section.

No. 3 Ideal for Cutting and Trimming Dies, Stamping and Embossing Dies, Punch Dies, Cups and Cones, Wood-Working and Forming Tools, Saw Swedges, Mining and Channeling Drills, Axes, Lathe Centers, large Milling Cutters, Taps, Reamers, Engraving Dies, Springs, Cutlery, Chisels, Shoe Dies. Weldable. Harden at full red heat. Approximate hardening range 1420° to 1460° F. depending on section.

No. 3½ For Cold Heading Dies, Cold Drop Dies, large Cutting and Trimming Dies, Punches, small Shear Knives, Cold Set, Caulking Tools, Clicker Die, Hand Chisels,

Pinch Bars, Springs, Cutlery. We have had most remarkable results with this steel for Cold Heading Work. Weldable. Harden at full cherry red. Approximate hardening range 1420° to 1480° F. depending on section.

No. 4 — For use in larger Shear Knives, Punches, Chisels, etc. For Sledges, Cold Set, Pneumatic Chisels, Track Chisels, Drop Forging Dies, Hammer Dies, Boiler Makers' Tools. Welds easily. Harden at bright cherry red. Approximate hardening range 1420° to 1480° F. depending on section.

No. 5 — For Track Tools, Hand Hammers, Drop Forging Dies, Rivet Sets, Snaps, Cupping Tools and Smith Shop Tools in general, etc. Welds easily. Harden at bright red. Approximate hardening range 1460° to 1540° F. depending on section.

No. 6 — For Hot Work generally, Hot Drop Forging, Rivet Heading, Smith Shop Tools, Wedges. Welds easily. Harden at bright red. Approximate hardening range 1460° to 1540° F. depending on section.

No. 7 — For Crank Pins and Machinery Parts, for such purposes that require a slight hardness combined with great toughness. Welds easily. Harden at bright red. Approximate hardening range 1460° to 1540° F. depending on section.

SANDERSON SPECIAL, EXTRA AND TOOL STEEL

TEMPER CLASSIFICATION

No. 6 — Suitable for Lathe, Planer and Slotter Tools for cutting very hard materials, Chilled Roll Turning Tools and Plugs, Razors, Gravers' Tools, etc. Use care in forging. Can be welded with great care. Hardens at a dark red. Hardening range approximately 1380° to 1430° F. depending on section.

No. 5½ — Suitable for Lathe, Planer and Slotter Tools, Chilled Roll Turning Tools and Plugs, Boring Tools, Gravers' Tools, small Taps, Reamers, Drills, Cutters, Forming Tools, Tube Drawing Dies and Plugs, Brass-Working Tools, Granite Chisels, Granite Drills, etc. Can be welded with care. Hardens at a dark red. Hardening range approximately 1380° to 1430° F. depending on section.

No. 5 — Suitable for Taps, Reamers, Drills, Milling Cutters, Nail Dies, Bolt Threading Dies, Screw Cutting Dies, Wood Moulding Knives, Bushings, Broaches, Mill Picks, Cutting and Blanking Punches and Dies, Cold Stamping Dies, Paper and Envelope Dies, Welded Planer and Paper Knives, Bush Hammers, large Thrust and Ball Bearings, Balls, etc. Can be welded with care. Hardens at a dark cherry red. Hardening range approximately 1400° to 1440° F. depending on section.

No. 4½ — Suitable for Taps, large Milling Cutters, Screw Cutting Dies, Pipe Dies, Cutting and Blanking Punches and Dies, Trimming Dies, Jewelers' Dies, Bushings, Scale Pivots, Bush Hammers, Cups, Cones, Ball Bearings, etc. Very suitable temper for a great variety of general shop uses. Weldable. Hardens at a cherry red. Hardening range approximately 1400° to 1450° F. depending on section.

No. 4 — Suitable for Trimming Dies, small Punches and Punch Dies, Leather Cutting Dies, small Chisels, Pene Hammers, Cold Heading Dies, Mint Dies, small Shear Blades, Axes,

Wood Bits, Hard Rock Drills, etc. Weldable. Hardens at a cherry red. Hardening range approximately 1420° to 1460° F.

No. 3½ Suitable for large Punches and Dies, Pneumatic Rivet Sets and Chisels, Hand Chisels, Cold Heading Dies, Shear Blades, large Trimming Dies, small Hammer Dies, Rock Drills, Mining Drills, Well Drills, Vise Jaws, Set Screws, Nail Sets, Spring Bushings, etc. Welds easily. Hardens at a cherry red. Hardening range approximately 1420° to 1480° F. depending on section.

No. 3 Suitable for large Hammer Dies and Drop Forging Dies, very large Shear Blades, Well Drills, Rail Chisels, Cold Sets, Sledges, Hammers, Button Sets, Hot Bolt and Rivet Dies, Smiths' Tools such as Flatters, Fullers, etc. Welds easily. Hardens at a bright cherry red. Hardening range approximately 1420° to 1480° F. depending on section.

No. 2½ Suitable for Hand Snaps, Sets and Cupping Tools for Hot Work, very large Hot Drop Forging Dies, Sledges, Hammers, Hot Sets, Smiths' Tools such as Flatters, Fullers, etc. For Hot Work and Battering Tools generally. Welds easily. Hardens at a bright red. Hardening range approximately 1460° to 1540° F. depending on section.

ATHA SPECIAL, EXTRA AND TOOL STEEL

TEMPER CLASSIFICATION

No. 1–A — Suitable for Razors, Dental and Engravers' Tools, Step Steel, etc. Use care in forging. Can be welded with extra care. Hardens at dark red. Approximate hardening range 1380° to 1430° F. depending on section.

No. 2–A — Suitable for Plugs, Lathe, Planer and Slotter Tools, for cutting very hard materials, such as Chilled Iron and Hard Steel Rolls, Granite Tools and Points, Engravers' and Dentists' Tools, etc. Use care in forging. Can be welded with care. Hardens at dark red. Approximate hardening range 1380° to 1430° F. depending on section.

No. $2\frac{1}{2}$–A — Suitable for Fine Cutters, Hair Clippers, Corrugating Tools, Lathe, Planer and Slotter Tools, small Taps, Reamers, Boring Tools, etc. Can be welded with care. Hardens at dark red. Approximate hardening range 1400° to 1440° F. depending on section.

No. $2\frac{3}{4}$–A — Suitable for Taps, Reamers, Milling Cutters, Nail Dies, Pivots, Threading Dies, Screw-cutting Dies, Wood Moulding Knives, Bushings, Broaches, Mill Picks, Paper Knives, Table Cutlery, Tobacco Knives, Twist Drills, etc. Can be welded. Hardens at dark cherry. Approximate hardening range 1400° to 1440° F. depending on section.

No. H D — Suitable for Thrust Bearings, Bush Hammers, Nail Dies, Cold Rivets, Pene Hammers, Files, Cutting Tools, Surgical Knives, Twist Drills, Taps, Reamers, Cutters and Dies for Cold Work, etc. Weldable. Hardens at cherry red. Approximate hardening range 1400° to 1450° F. depending on section.

No. 3–A — Suitable for Punches, Minting, Cold Stamping and Leather Cutting Dies, Cups, Cones, Bushings, Ball Bearings and Wood-Working Tools. Weldable. Hardens at a full red heat. Approximate hardening range 1420° to 1460° F. depending on section.

No. 3½–A Suitable for Dies, Pneumatic Rivet Sets, Plungers, Cams, Hand Chisels, Coal Miners' Drills, Rock Drills, Masons' Tools, Well Drills, Shear Blades, Vise Jaws, Set Screws, large Trimming Dies, Wood-Working Tools, etc. Weldable. Hardens at full cherry red. Approximate hardening range 1420° to 1480° F. depending on section.

No. 4–X Suitable for Artisans' Snaps, Button Sets, large Shear Blades, Wrench Jaws, Drill Chucks, etc. Welds easily. Hardens at bright cherry red. Approximate hardening range 1420° to 1480° F. depending on section.

No. 4–A Suitable for Die Blocks, Button Sets, Pneumatic Chipping Tools, Rivet Dies, Smiths' Tools, Sledges, etc. Welds easily. Hardens at bright cherry red. Approximate hardening range 1420° to 1480° F. depending on section.

No. 6–A Suitable for Battering Tools, Flatters, Fullers, Hot Sets, Band Snaps, Set and Cupping Tools, etc. Welds easily. Hardens at bright red. Approximate hardening range 1460° to 1540° F. depending on section.

No. 7–A Suitable for Mandrels, Rivet Headers, Railroad Track Chisels, Large Hot Drop Hammer Dies. Welds easily. Hardens at bright red. Approximate hardening range 1460° to 1540° F. depending on section.

HOWE SPECIAL, EXTRA AND TOOL STEEL

TEMPER CLASSIFICATION

A. MADE ONLY IN SPECIAL TOOL.
Suitable for Lathe and Planer Tools for Chilled Iron or extra hard work. Harden at dark red. Hardening range approximately 1380° to 1430° F. depending on section.

B. MADE ONLY IN SPECIAL TOOL.
Suitable for Lathe and Planer and Brass Tools, Drills, Drawing Dies, Granite Chisels, Roll Turning and all Cold Cutting Dies, where high temper is required. Harden at dark red. Hardening range approximately 1380° to 1430° F. depending on section.

C. Suitable for Milling Cutters, Taps, Reamers, Drills, Moulding Bits, Punches, Dies, Threading Dies, Edge Tools, etc. Harden at dark red. Hardening range approximately 1400° to 1450° F. depending on section.

D. Suitable for small Shear Knives, Punches, Mining Drills, Miners' Machine Drills and Boiler Makers' Chisels, Drifts, Drop Forging and Trimming Dies. Harden at fair red. Hardening range approximately 1420° to 1480° F. depending on section.

E. Suitable for Track Chisels, Machinists' and Blacksmiths' use, Cold Sets, Shear Knives, Track Tools, Sledges, Stone Cutters' Tools, Button Sets, and Hot Forging Dies. Harden at fair red. Hardening range approximately 1460° to 1540° F. depending on section.

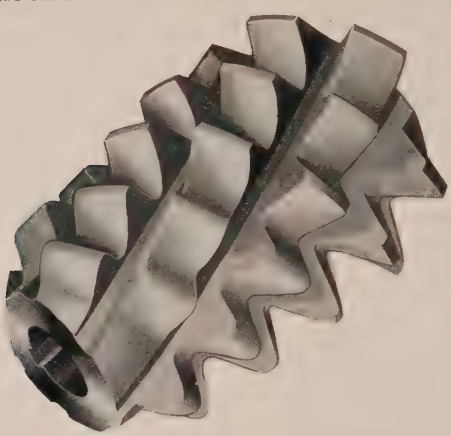
F. Suitable for Hammer Dies, Forging Dies, Smith Shop Tools, Fullers, Flatteners, Hot Sets and in general where work is heavy and great toughness is required. Harden at full red. Hardening range approximately 1460° to 1540° F. depending on section.

TEMPERING COLORS AND TEMPERATURE IN DRAWING CARBON STEEL

The tempering colors which successively appear on the filed surface of hardened steel, slowly heated, are approximately as follows:

Very faint Yellow	420° F.
Yellowish White or Light Straw	430° F.
Light Yellow	440° F.
Pale Yellow Straw	450° F.
Straw	460° F.
Dark Yellow	470° F.
Deep Straw	480° F.
Yellow Brown	490° F.
Brown Yellow	500° F.
Brown	510° F.
Brown Purple (Peacock)	520° F.
Light Purple	530° F.
Purple	540° F.
Dark Purple	550° F.
Light Blue	560° F.
Blue	570° F.
Dark Blue	600° F.
Blue tinged with Green	625° F.

These figures are for use only when employing an oil tempering bath or a muffle furnace.



SPECIAL STEELS FOR SMALL TOOL MAKERS

For many years we have furnished nearly all of the small tool manufacturers a large variety of steels for various types of tools such as cutters, reamers, broaches, taps, dies and drills, in high speed, alloy and carbon tool steels.

There is no one industry that has been more progressive, in order to keep step with modern developments, than this one. This was largely due to the fact that it has been absolutely necessary to produce tools which will fabricate successfully the more recent developments in modern alloy steels.

That particular industry employs extensively the best metallurgical skill obtainable and is most exacting in its requirements and in its specifications to the tool steel manufacturers. In this progress we have made every effort to co-operate and, we have reason to believe, with success.

We have kept Rex "AA" abreast of the times and the most rigid specifications of several of the largest small tool manufacturers, both chemically and physically, are fully met with this widely used High Speed Steel.

In the alloy and carbon steels for drills, taps, dies, etc., we have developed carefully the ideal annealing and structure best suited to various types of tools, whether furnished hot rolled, cold drawn or cold rolled.

We do not believe there is a requirement of this exacting industry that is too particular or difficult for us to meet consistently.

HOT ROLLED SHEET STEEL

CARBON TOOL STEEL.—We make a specialty of Hot Rolled Sheet Steel of accurate gauge and fine finish for such purposes as Pocket and Table Cutlery of the highest grade, Cold Metal Saws and Springs.

These sheets are of smooth surface, free from pits and other imperfections and readily take the high polish frequently required on fine blades and tools of special character. We furnish unannealed, floor annealed, or annealed sheets as required. Special, Extra, First Quality, Second Quality and Third Quality Grades may be had in all standard tempers.

We also furnish Hot Rolled Sheet Steel suitable for shovels, trowels, and other general purposes.

We carry a well assorted stock of Hot Rolled Sheet Steel at our Branch warehouses.

Prices subject to Hot Rolled Sheet Steel Classification of Extras, as shown on page 80.

SHOVEL SHEET

Straight Carbon and Alloy
Crucible, Electric and Special O. H.

Prices on application.

HOT ROLLED SHEET STEEL
CLASSIFICATION

CARBON SHEET STEEL

No. 14 ga. (.083) and heavier.....Base

EXTRAS FOR LIGHTER GAUGES

	Extra per Lb. Cents		Extra per Lb. Cents
No. 15 ga. (.072)	½	No. 22 ga. (.028)	6
No. 16 ga. (.065)	1	No. 23 ga. (.025)	8
No. 17 ga. (.058)	3	No. 24 ga. (.022)	10
No. 18 ga. (.049)	3	No. 25 ga. (.020)	12
No. 19 ga. (.042)	4	No. 26 ga. (.018)	14
No. 20 ga. (.035)	4	No. 27 ga. (.016)	16
No. 21 ga. (.032)	5	No. 28 ga, (.014)	18

Gauges lighter than No. 28 (.014) special price.

THE FOLLOWING EXTRAS FOR SHEARING SHEET STEEL

To widths:

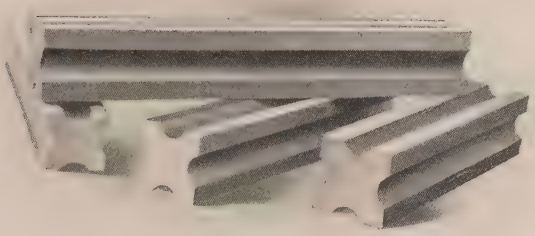
⅜″	6c. per lb.
½″	5″ " "
¾″	4″ " "
1″	3″ " "
1⅛″ to 2″	2″ " "
2″ and over	1″ " "
Over 24″	2″ " "
Shearing to any length	1″ " "

Thicknesses given in this list are Birmingham Wire Gauge.

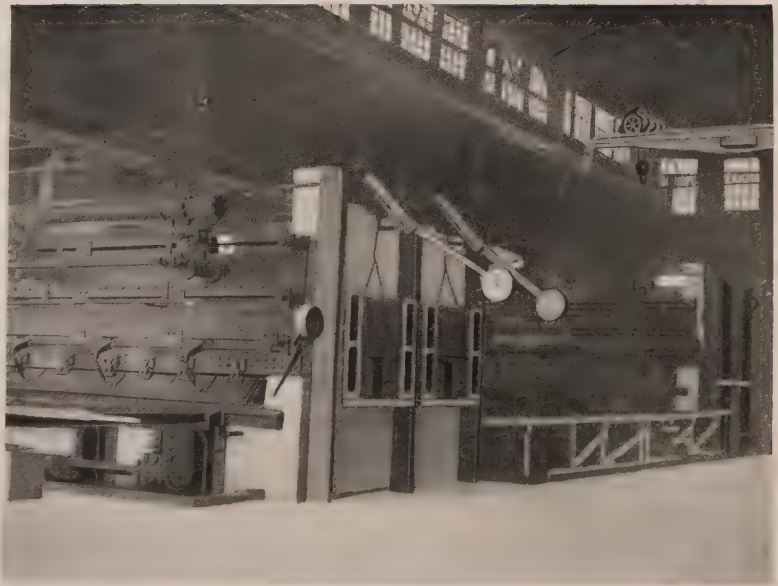
Unless otherwise instructed the width of sheets furnished will be 18 inches; lengths from 42 to 72 inches. When sheets are ordered by gauge we furnish same to the Birmingham Wire Gauge. It is better, however, to specify in decimals of an inch.

ROLL TURNING TOOLS

FINISHED—HARDENED—READY FOR USE



These Tools are made from our various Brands of High Speed Steels, Double Special or Special Tool Steels, fluted and carefully treated to give the correct degree of hardness for each kind of tool. High Speed Steel Tools are recommended for high speed roughing cuts. Double Special will make the finest finishing cut. Special Tool Steel will also make a good finishing cut on hard chilled rolls.



HEAT TREATING PLANT

DIE STEELS
AND
DIE BLOCKS

DIE STEELS

Our various grades of Die Steel are designed for severe usage and record-breaking service. From the initial stage of manufacture and throughout each succeeding step, every department through which the steel passes, and every workman who helps to complete it, understands full well that QUALITY must characterize the steel.

ANNEALED WIRE NAIL DIE SHAPES

Rex "AA" High Speed Steel.

Prices subject to High Speed Steel Classification of Extras, as shown on pages 24–25.

Special, Extra and Standard.

Prices subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

Double bevels, annealed, of standard size, for Nail Machine Dies and Cutters; also square and flat shapes. Bevels are 10 degrees.

COMPOSITE DIE STEEL

One Side Hard—One Side Soft

Special and Extra Die Steel.

Prices subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

DROP DIE AND BOLT DIE STEEL

In Bars and Blocks

Special, Extra and Standard.

When ordering, specify if for Hot or Cold Work.

Prices subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

SCREW, RIVET AND COLD HEADING DIE STEEL

Alva Extra Alloy Tool Steel.

Extra Cold Heading Die Steel.

Prices subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

ANNEALED WIRE NAIL DIE SHAPES

REX "AA" AND REX "A" HIGH SPEED SANDERSON "SPECIAL", "EXTRA" AND "TOOL" GRADES FOR WIRE NAIL MACHINE DIES AND CUTTERS

Double Bevels, annealed, of standard shapes and sizes carried in stock or rolled to order, as follows:

DOUBLE BEVELS (ALL 10°)

No.	Width Across Base Inches	Height Inches	No.	Width Across Base Inches	Height Inches
1	3	2 1/4	17	1	11/16
2	2 5/8	1 3/4	18	1 1/8	9/16
3	3	1 3/8	19	15/16	9/16
4	2 1/2	1 3/8	20	1 1/16	11/16
5	2	7/8	21	15/16	11/16
6	2 1/8	1 1/16	22	1 1/16	9/16
7	1 27/32	1 3/8	23	13/16	9/16
8	1 5/8	1 1/8	24	1 5/16	9/16
9	1 13/16	15/16	25	15/16	1/2
10	1 1/2	15/16	26	11/16	7/16
11	1 1/2	13/16	27	5/8	3/8
12	1 1/2	9/16	28	3/4	9/16
13	1 1/2	11/16	29	23/32	1/2
14	1 3/8	13/16	30	11/16	15/32
15	1 1/4	11/16	31	1/2	11/32
16	1 1/8	11/16	...	...	..

SQUARE

No.	Size, Inches	No.	Size, Inches
44	1 1/16	49	51/64
45	13/16	50	43/64
46	11/16	51	9/16
47	5/8	52	7/16
48	1 1/32	53	35/64

In ordering please state the size number.

ANNEALED WIRE NAIL DIE SHAPES—Continued

FLAT

No.	Size, Inches	No.	Size, Inches
54	$1\frac{3}{16}$ x $\frac{7}{8}$	60	$\frac{11}{16}$ x $\frac{15}{32}$
55	$1\frac{1}{16}$ x $\frac{11}{16}$	61	$\frac{9}{16}$ x $\frac{7}{16}$
56	1 x $\frac{11}{16}$	62	$\frac{35}{64}$ x $\frac{13}{32}$
57	$\frac{11}{16}$ x $\frac{7}{16}$	63	$\frac{1}{2}$ x $\frac{7}{16}$
58	$1\frac{1}{32}$ x $\frac{3}{4}$	64	$\frac{3}{8}$ x $\frac{7}{16}$
59	$\frac{11}{16}$ x $\frac{5}{8}$	65	$\frac{7}{16}$ x $\frac{13}{32}$

In ordering, please state the size number.

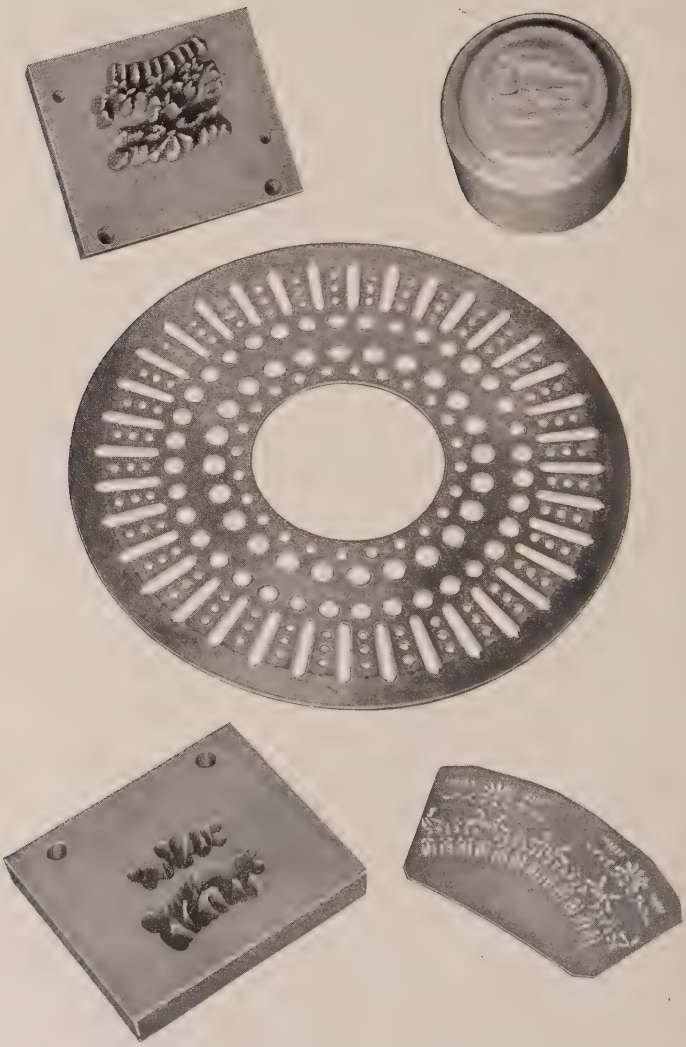
DRAWING DIE (WORTLE) STEEL

This is a very high grade, high duty, wire die steel, made in several grades for different classes of work, and suitable for drawing steel, iron, brass, copper or other metals. It is furnished in bars and unpierced plates. It requires no hardening, but can be drilled and reamed with good tools.

Let us know the kind of work being done—whether breaking down or finishing, large or small sizes, rounds or shapes, low or high carbon, steel or copper—and we will furnish a wortle adapted to your particular needs.

TACK DIE STEEL

Sanderson Tack Die Steel is the result of experiment and study and is strongly recommended for this special field. No heat treatment is necessary by the user of this steel.



JEWELERS' DIES MADE FROM SPECIAL TOOL STEEL

JEWELERS' FORGED DIE BLOCKS AND ROLL BLANKS

Steel used for jewelers' rolls and for blanking, cutting and stamping dies, must be of the highest possible quality. Carefully selected materials must be employed, as well as methods of manufacture, to insure the production of sound stock of uniform quality, perfectly adapted to the purpose intended.

Special Tool Steel is an ideal steel for such uses, as it embodies all the features which impart to the tool or dies those characteristics which enable it to give long continued service without breakage or sinkage, no matter how severe the service or how intricate the design.

To the user, a dependable steel means increased output and decreased factory costs.

To secure even hardening of Die Block Steels, it is well to take off plenty of the surface when machining to get below the scale and the slight surface decarbonization which has occurred during annealing.

DIE BLOCKS AND CUTTER BLANKS

FORGED—ANNEALED

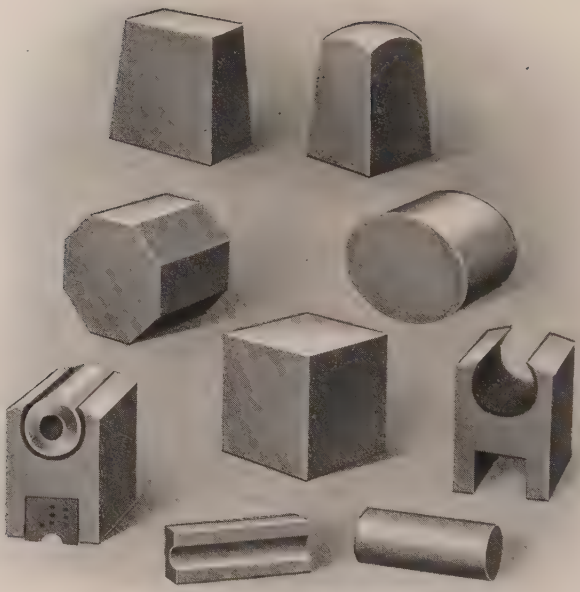
We supply Die Blocks of all shapes in Special Die Steel, of tempers selected for each class, including minting dies, engraved stamping dies, portrait and monogram dies, medal dies, pin heading dies, blanking and drawing dies, spoon, fork and knife handle dies, etc.

We also supply other Carbon Steels and High Speed Cutter Blank Discs, all carefully annealed, ready for machining.

TOOL AND DIE STEEL FORGINGS

Steel Forgings to sketch or blue print in Special, Extra and Standard Tool Steel, at prices according to the grade, shape and size.

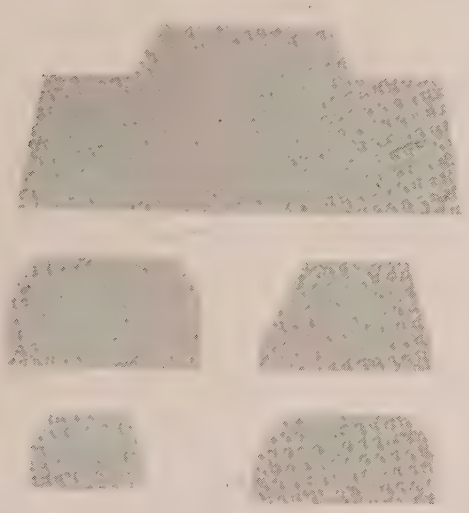
Annealed or unannealed, as desired.



JEWELERS' DIE BLOCKS AND SWEDGING DIES

HEADING DIE STEEL

For heading dies for both hot and cold work, used in automatic nut and bolt machines, pneumatic tools and all similar classes of work, we recommend our "La Belle" products to the user who demands the highest possible service and efficiency. Extreme care is used in the manufacture of these Steels, the aim being to have them thoroughly homogeneous and relieved from all internal strains.



These features are important to insure accuracy and durability in the finished tools and are characteristic of our "La Belle" products. Heading Die Steel is supplied in rounds, squares, flats and special sections.

Particular attention is called to our "La Belle" Extra Tool Steel, No. 3 and No. 3½ Temper, for use in cold heading dies. Our customers have had most remarkable results from this steel. We will gladly advise special hardening and tempering practice to fit your particular requirements.

SHOE DIE STEEL

For Shoe Dies—Clicker Dies—Envelope Dies, etc.

Furnished in plain bevel, single and double bevel or V shape and corrugated.

Certain standard sizes and shapes carried in stock at Branch warehouses. Can always ship promptly from Mill.

DIE BLOCK AND DISC CLASSIFICATIONS

FORGED CARBON TOOL STEEL

To the base price of the steel used add the following extras:

	Die Blocks	Discs
Over 25 lbs. weight	2c. lb.	3c. lb.
15 lbs. to 25 lbs	3c. "	5c. "
10 lbs. to 15 lbs	5c. "	6c. "
7½ lbs. to 10 lbs	7c. "	7c. "
5 lbs. to 7½ lbs	8c. "	8c. "
3 lbs. to 5 lbs	9c. "	9c. "
2 lbs. to 3 lbs	11c. "	11c. "
1 lb. to 2 lbs	12c. "	12c. "
Under 1 lb. weight	Special Price	

If annealed—add 1c. per lb. to above extras

FORGED RECTANGULAR DIE BLOCKS

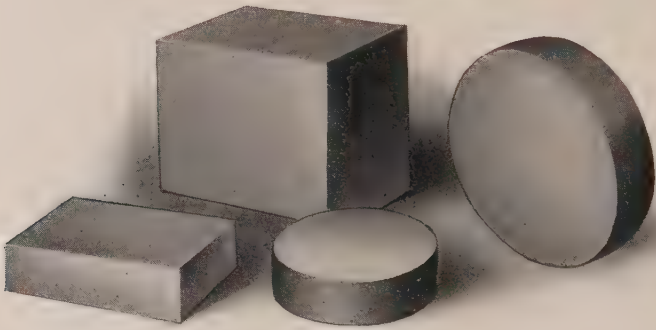
(Except Tool Steel Grades)

200 lbs. each and heavier	Base
Over 99 lbs. up to 199 lbs., inc.	1c. lb. extra
Over 49 lbs. up to 99 lbs., inc.	2c. " "
Over 35 lbs. up to 49 lbs., inc.	4c. " "

These extras for weight do not cover Die Blocks in which the width, length or thickness is less than 5". Prices for such smaller blocks will be supplied upon request.

Treating or Annealing is included in the base price.

FORGED DISCS, RINGS AND DIE BLOCKS



The basis used in computing prices of Discs, Die Blocks or Rings made of Crucible Steel is the value of the finished bar.

In requesting Quotations, please give grade required and for what purpose to be used.

Rings carry the same extras for weight as a solid disc, of the same outside measurements. There is also an extra charge of three cents per pound for labor required to cut the hole, plus a charge for the weight of steel represented by the hole.

RULE FOR COMPUTING PRICE OF RINGS:

Multiply the weight of solid disc by base price of the steel, and divide result by weight of the ring. Add disc extra according to disc classification for solid disc and three cents per pound for labor in cutting hole. The result will be the selling price per pound of ring.

EXAMPLE:—Using 24c. per pound base, compute the cost of a ring $9\frac{1}{2}$ inches outside diameter, 1 inch thick, or face, with $4\frac{1}{4}$ inch hole.

Weight of solid disc	$9\frac{1}{2}$ x 1	20 lbs.
" " disc	$4\frac{1}{4}$ x 1 (hole)	4 "
" " ring		16 "

Following the rule $\frac{20 \times 24}{16} = 30$c. per lb. base price of ring.

Add

Extra as per Disc Classification for solid Disc 20 lbs	5c. per lb.
Cost for cutting hole	3c. " "
Annealing	1c. " "
Net selling price of Ring	39c. " "

DIE BLOCKS

Close scientific study has been given by the Crucible Steel Company of America to the manufacture of Die Blocks for drop forging. It is not only essential that the chemical composition be correct, but it is of equal importance that the steel be properly worked in its manufacture, to produce that soundness and density which is required to withstand the terrific strains in service.

All the stock made into Die Blocks is the product of our own furnaces, and the uniformity thus secured is an important factor in determining their ultimate success. The large ingots are then worked down thoroughly under hammers, or hydraulic presses, so that a dense structure is obtained throughout the whole block.

Heat treating of Die Blocks (ready for use without hardening) is an important feature of our service. We furnish all grades of Die Blocks heat treated to any hardness specified.

The economical buyer will always remember that the expense of die sinking and the economy of long continued runs are two highly important items in determining shop costs. It is, therefore, a manifest saving to select that grade of block, the quality of which will offer the greatest resistance to wear and give the longest service.

DIAMOND ALLOY DIE BLOCKS

Heat Treated, Ready for Use

No hardening nor heat treatment of any kind is required on the part of the user. New impressions can be made when one job is finished and the blocks thus used continually until worn out. They are in general use for heavy, difficult work, although most excellent results have been obtained from them in the forging of fine tools, such as scissors, scalpels and pocket-knife blades.

CRUCIBLE ALLOY COMPRESSED DIE BLOCKS

Heat Treated, Ready for Use

Furnished in condition for sinking the impression and use without hardening. The structure of these blocks is very dense and shows marked resistance to wear under hard usage. They are particularly adapted to difficult forging work from which a large output is desired.

EXCELSIOR DIE BLOCKS

Annealed or Heat Treated

These are of special open hearth die block composition, hammer forged all over and intended to be hardened by the user. A superior block for general purposes and one which can be relied upon.

STANDARD DIE BLOCKS

Annealed or Heat Treated

These are our standard open hearth blocks, machine cut to the required length from thoroughly forged and annealed bars. They are to be hardened by the user.

SPECIAL ALLOY STEEL FOR DIE-CASTING DIES

This steel has met with great success among the many manufacturers in this country operating die-casting machines for making aluminum castings under high pressure. This work involves rapid temperature changes, when the molten aluminum strikes the metal mold, is chilled, ejected, and the cycle repeated continuously. On account of the intricate dies and the great expense involved in their preparation, a steel possessing maximum hardness and toughness is required. It must be sound and clean so as to reduce the possibility of failure to the absolute minimum.

This Special Chrome Vanadium Steel is of a special mix perfected for this particular purpose. The great care exercised in the selection of raw materials and melting render it remarkably free from segregations and other defects which are likely to appear in highly alloyed steels. This is one of the main points in its favor, since steel for this work must be absolutely clean and sound in order to preserve a perfect surface.

Another advantage is the fact that it is a comparatively easy steel to heat treat, and there is not the danger of losing a very expensive finished part that exists in less suitable steels. This steel also resists the pitting which would ordinarily be feared from the alloying action of hot aluminum.

After treatment, the extreme outside surface of the dies becomes very hard, thus preventing wear. The area directly underneath is

backed up by a slightly softer but very tough core, which acts to prevent surface cracks resulting from the constant expansion and contraction in service.

We are prepared to furnish this material in bars, forgings, discs, or blocks to meet individual requirements.

Prices subject to Carbon Tool Steel Classification of Extras, as shown on pages 64–65.

SUGGESTIONS FOR HEAT TREATING

Special Chrome Vanadium Steel should ordinarily be quenched in oil at a temperature of about 1600° to 1650° F. and drawn to obtain the hardness desired. A drawing temperature of around 800° F. will give a Brinell hardness of about 450 F°.

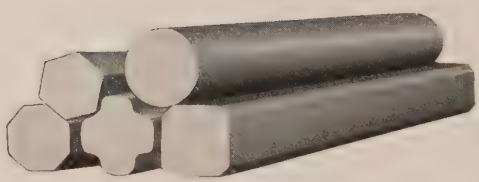
ENGRAVER PLATE STEEL

The requirements for engravers' transfer plate are very exacting and to meet those requirements we have been conducting investigations for many years to produce a quality thoroughly satisfactory in analysis, texture and hardness to meet the needs for this material and capable of taking a high degree of finish.

This steel is furnished in any size of plates desired and to any thickness, and in condition ready for planing, grinding, beveling and polishing. The material is subject to the closest scrutiny before shipment.

Prices on application.

HOLLOW DRILL STEEL



SOLID DRILL STEEL

MINING
AND
ROCK DRILL
STEELS

MINING AND ROCK DRILL STEELS

SOLID AND HOLLOW

Our various brands of mining and rock drill steels, which embrace every conceivable requirement or application in this field, have been the accepted standard in the mining and quarrying districts throughout the United States, Canada and Mexico for over half a century.

This reputation comes as a consequence of constantly keeping in close touch with the actual operating conditions in the field and taking pains to see that our product measures up in all respects to present day requirements.

These steels are made in all standard shapes, as follows:

Hollow Drill Steel—Rounds, Hexagons, Octagons and Quarter Octagons.

Solid Drill Steel—Rounds, Hexagons, Octagons, Quarter Octagons, Cruciform in Rocky Mountain and Lake Superior pattern.

We are in position to supply these various grades and sizes in the natural, annealed, normalized, or heat treated and annealed condition.

Our New Process Hollow Drill Steel is manufactured by a method controlled by our own patents. It meets a long-felt need among all users of mining and quarry drill steels. The hole is as near the exact center of the bar and as uniform in size and shape throughout as mechanical exactness and accuracy can make it. Its finish is clean and smooth, and there is no tendency for cracks to form and spread from the hole outward in the working of the drill.

In the following pages we will briefly describe some of our foremost brands of mining and rock drill steel and their various applications.

PEERLESS EXTRA DRILL STEEL
SILVER DRILL STEEL
ATHA CHAMPION EXTRA DRILL STEEL
CRESCENT EXTRA DRILL STEEL
EXTRA QUARRY DRILL STEEL

Our Extra Quality Mining and Rock Drill Steels listed above have proved their excellence in cutting quartz, granite, or hard rock mixed with jasper.

Drills made of these steels give long service. Losses of time and money caused by drill breakages and frequent redressings are eliminated. Such noteworthy features of these grades testify to their fine quality.

The above steels are especially recommended for the manufacture of Bush Hammers, 4-Point Surfacing Tools, Plug Drills, Hand Drills and Points and Turning Discs.

These steels should never be quenched from the forging heat. Allow the bit to cool naturally, and then reheat for hardening. This practice will overcome all forging strains and uneven cooling at the cutting edge of the bit, which is bound to occur if the steel is forged and hardened at the same heat.

In this connection, we call attention to our Service Department. We employ a staff of skilled and practical men, who are experienced in the successful handling of drill steels. These men are at the command of our customers, and will cheerfully give detailed suggestions as to the best method of forging and hardening, or, where required, will make an actual demonstration.

ALVA (VANADIUM ALLOY) DRILL STEEL

This is the latest development in alloy drill steel and is being used with great success on exceptionally severe work where steel of great toughness and strength combined with maximum hardness and abrasive resistance is required. The slightly greater cost of this material is more than compensated for by greater service and longer life.

This grade is furnished in both solid and hollow sections.

BLACK DIAMOND (PARK) DRILL STEEL
CRESCENT DRILL STEEL
HOWE DRILL STEEL
ATHA CHAMPION DRILL STEEL
CANTON EXTRA DRILL STEEL

These steels hold an enviable record, not only in America but throughout the World, for cutting hard rock and granite with minimum damage to the drills' cutting edge. They are especially adapted to power drills, hand drills and "jumpers", and offer the greatest resistance to vibratory shock which cannot be avoided during the stress and strain of severe usage. The economy which results from the use of these brands of steel, due to infrequent stoppages and redressing, should alone commend them to the thoughtful user. These grades are furnished in both solid and hollow sections.

These steels harden readily, and do not "spall off" on the head or split under impact.

Large stocks of standard sizes and shapes are carried at Branches.

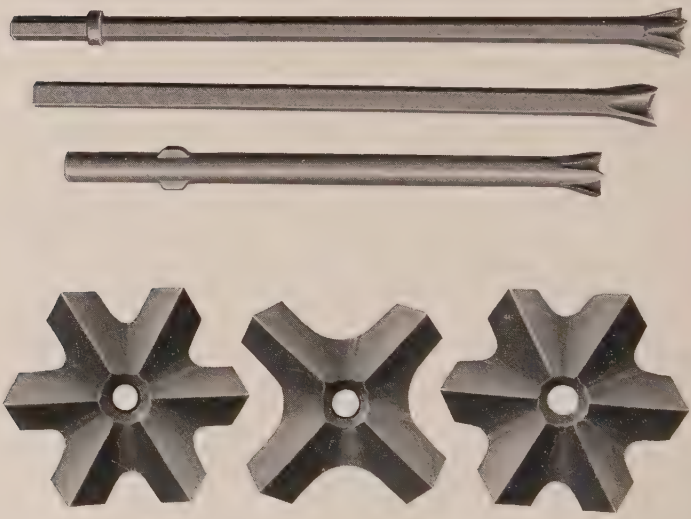
CANTON BUCKEYE DRILL STEEL
CORONA DRILL STEEL
C.H.C. DRILL STEEL
KEYSTONE DRILL STEEL

These grades are also well known for their ability to stand up under severe punishment. However, they are particularly suitable to work which is not severe enough to warrant the use of one of our higher grades.

HOLLOW AND SOLID FINISHED DRILL BITS

In all standard sizes and sections and in lengths up to 40 feet over-all.

HOLLOW DRILL BITS furnished in round, hexagon, quarter octagon and octagon sections, with 4-point cross bits and 6-point rose bits, bitted, collared or lugged, shanked and hardened ready for use.



SOLID STEEL DRILL BITS supplied in cruciform shape, Rocky Mountain pattern, Light Section, and Lake Superior pattern, Heavy Section, with 4-point cross bits (no collar), hardened, etc., ready for service.

Drill Bits with special size bits or with special length shanks can be furnished. When ordering, specify the type of bit, also the bit diameter, and over-all length.

COAL AND MINE BIT STEEL

For all styles of hand and power machines, carefully and accurately rolled in flats, squares and special sections, such as oval and diamond shapes.

MISCELLANEOUS STEELS FOR MINING DRILL PARTS

Pistons
Chucks
Keys
Feed and Jack Screws
Combination Chucks and Pistons
Pitman Shafts
Tappet Keys
Rotating Bar Forgings
Pump Thrust Bearings
Friction Bolt Forgings
Rock Breaker Forgings
Set Screws
Jaw Shafts
Skip Pins
Feed Nuts
Chuck Bolts
V Bolts

MISCELLANEOUS STEELS FOR QUARRYING PURPOSES

Dog
Gang Saw Key
Shim
Wedge
Stirrup
Stone Saw
Quarry Pick

WELL BITS AND JAR

OIL WELL DRILLING STEELS

OIL WELL DRILLING STEELS

Since the Drilling of the Drake well in Pennsylvania, our Company has been privileged to aid in the development of the engineering and manufacturing of steel for oil well tools and accessories and during all the long period that has elapsed since that time, we have kept in touch with the developments in the industry and are, therefore, fully experienced as to what the Toolmaker and Driller requires. We know that the Toolmaker is looking for the highest quality of materials for his tools to fit the job, and we know that the Driller is after the best steel he can get with which to drill his well with the least loss of time and the greatest degree of progress.

CRESCENT HAMMERED BIT AND JAR STEELS

These steels have been the standards among Well Drillers for many decades—they are made for hard usage and efficient service. In every part of the world where oil, gas and artesian wells are drilled, these steels enjoy a reputation shared by no others made for similar purposes. During the years of development, we have been ever mindful of the importance of maintaining the necessary high standard of quality to meet changed conditions, in order that the splendid success of our steels in the past will continue.

These steels are made from carefully melted and specially selected stock of analyses designed to give the best results; each piece is thoroughly hammered to produce a sound dense structure of uniform quality. Every piece is carefully inspected and is free from seams and surface defects. It possesses remarkably great cutting power and endurance.

This steel is easy to forge and responds readily to treatment.

We supply Bit Steel in all sizes of squares and flats, in straight pieces cut to given lengths and weights per piece, and with rounded shank end, if desired, to any diameter and taper.

Jar Steel is furnished with nicely rounded corners and nicked in the center, if desired, so that both reins can be made from the same piece.

CRUCIBLE STEEL COMPANY OF AMERICA

Due to the evolution taking place in drilling, requiring increased physical values in the steel during recent years, we have been called upon to provide the best metallurgical skill and manufacturing processes obtainable. To meet these new conditions, we are furnishing ALLOY STEELS for all types of Drilling Tools, made by the Special Open Hearth and Electrically Melted methods, as follows:

CHROME BIT AND JAR STEEL
VANADIUM BIT AND JAR STEEL

In addition to these steels for Drilling purposes, we also manufacture steels of a special character for

JAR CAPPING	SLIP SOCKETS
BOXES AND PINS	COMBINATION SOCKETS
STEMS	ROPE SOCKETS
DRIVE SHOES	HORN SOCKETS

and FISHING TOOLS of all descriptions.

The Crucible Steel Company of America, with its extensive and complete melting and finishing equipment and controlling within its own manufacturing its raw materials, and purchasing only the highest grade alloys, is "father" to every operation and therefore can maintain the quality of its products.

SAW STEELS

BAND SAW STEELS

FILE STEELS

SAW STEEL

Our Saw Steel grades are suitable for a great variety of purposes, and possess all those qualities which attract the saw manufacturer and the ultimate user. The painstaking care which attends every mill operation insures excellent steel, uniform rolling, correct shearing and unusual freedom from scale, pit marks, and other surface imperfections. Tools made from our Saw Steel therefore require a minimum amount of grinding. These steels are used for a host of purposes, such as **Hand and Cross Cuts, Gang, Drag, Circular, Shingle, Groover, Hot and Cold Friction and Slate Saws.**

For **Metal Milling** and similar work, we have developed several special grades, the efficacy of which have been fully tested and their superiority demonstrated. Where extraordinary cutting properties and resistance to wear are desired, these latest developments in Saw Steel making will solve your problem.

Tungsten Hack Saw Sheet Steel is being produced for a large number of satisfied users. We have devoted our best efforts and enlisted our extensive facilities in the manufacture of sound steel of this grade, uniform in gauge, that cuts faster and wears longer than any other on the market.

CIRCULAR SAW PLATES

Base Sizes, 10 inches to 46 inches

Extra Prices for Extra Sizes.

Diam. Inches	48	50	52 to 54	56 to 60	62 to 64	66 to 70	72
Cents Extra per pound	1	2	3	5	7	9	11

	Cents Extra per lb.
Less than 10 inches diameter; not less than 8 inches	2
" " 8 " " " " " 6 "	4
" " 6 " " " " " 4 "	6

BAND SAW STEEL

HOT ROLLED

Furnished in:

Special Tool Steel

Extra Tool Steel

Standard Tool Steel

Base Sizes:

$2\frac{1}{2}$ inches wide and over by No. 14 gauge (.083) and heavier. Under $2\frac{1}{2}$ inches wide subject to special price.

We roll Band Saw Steel to 15 inches wide, of usual lengths.

Refer to the section on Cold Drawn and Cold Rolled Steels for further reference to Saw Steels, such as Wood, Butcher, and Metal Cutting Band Saw Steel.

HACK SAW SHEET STEEL

Furnished in either Tungsten or Straight Carbon.

Prices on application.

FILE STEEL

We are prepared to supply Crucible, Electric and Special Open Hearth—Straight Carbon and Alloy.

BASE SHAPES AND SIZES

Square, Half-Round, Round and Flat, Cabinet, Mill Saw, Horse and Shoe Rasp, 8-inch and over, are "Base" shapes and sizes at base price.

EXTRA SHAPES, 8-INCH AND OVER AT EXTRA PRICES

	Cents Extra per lb.
Knife, Slitting, Cross, Tumbler, Saddle Tree, Rasp, Oval, Cant, Feather-Edge, Shoe, Roller, Gin Saw, Pit Saw, Cross-Cut (except Great American)	3
Great American Cross-Cut, 8-inch and over	2
Taper and Slim Taper—extra for SHAPE IN ADDITION TO CLASSIFICATION	2

All Special Shapes not otherwise provided for, 8-inch and over, 3½

EXTRAS FOR ALL FILE AND RASP STEEL

EXCEPT TAPER AND SLIM TAPER

Inch	7½	7	6½	6	5½	5	4½	4	3½	3
Cents Extra, per pound	½	1	1½	2	2½	3	3½	4	4½	5

TAPER FILE STEEL

4-inch and over	Base

EXTRAS FOR TAPER

Inch	3½	3
Cents Extra, per pound	1	4

SLIM TAPER FILE STEEL

6-inch and over	Base

EXTRAS FOR SLIM TAPER

Inch	5½	5	4½	4	3½
Cents Extra, per pound	½	1	2½	4	6½

FILE STEEL

FILE STEEL SIZES

Size	Square and Round	Flat	Mill	Taper	Half-Round
2 in.	.075	.240x.060	.240x.045	.134	.240x.069
2½ "	.094	.288x.072	.288x.054	.167	.288x.082
3 "	.113	.335x.084	.335x.063	.234	.336x.096
3½ "	.131	.384x.096	.384x.072	.302	.383x.109
4 "	.150	.430x.107	.430x.081	.369	.431x.123
4½ "	.169	.478x.119	.478x.089	.402	.479x.137
5 "	.188	.525x.131	.525x.098	.436	.527x.151
5½ "	.206	.573x.143	.573x.107	.470	.574x.164
6 "	.225	.620x.155	.620x.116	.503	.622x.178
6½ "	.....	.668x.167	.....	.....	.....
7 "	.263	.715x.179	.715x.134	.570	.718x.205
8 "	.300	.810x.202	.810x.152	.638	.813x.232
9 "	.338	.905x.226	.905x.170	.705	.909x.260
10 "	.375	1.000x.250	1.000x.187	.772	1.004x.287
11 "	.438	1.090x.272	1.090x.204	.839	1.100x.314
12 "	.500	1.180x.295	1.180x.221	.906	1.195x.341
13 "	.563	1.270x.317	1.270x.238	.973	1.291x.369
14 "	.625	1.360x.340	1.360x.255	1.041	1.387x.396
15 "	.688	1.450x.362	1.450x.272	1.108	1.482x.423
16 "	.750	1.540x.385	1.540x.289	1.175	1.578x.451
17 "	.813	1.630x.407	1.630x.306	.....	1.673x.478
18 "	.875	1.720x.430	1.720x.322	.....	1.769x.505
19 "	.938	1.810x.452	.....	.....	1.864x.533
20 "	1.000	1.900x.475	.....	.....	1.960x.560
21 "	1.063	.....	.....	.....	.....
22 "	1.125	.....	.....	.....	.....
23 "	1.188	.....	.....	...	.....
24 "	1.250	.....	.....	.....	.....

AGRICULTURAL IMPLEMENT STEELS

FOR

PLOWS, HARROWS, GRAIN DRILLS,
CULTIVATORS
MOWING AND HARVESTING MACHINERY
ROAD MACHINERY
GARDEN IMPLEMENTS
LAWN MOWERS

AGRICULTURAL IMPLEMENT STEELS

LA BELLE PLOW AND IMPLEMENT STEELS

Of commanding importance in the United States and Canada, and to the World by reason of the tremendous and increasing exports from these countries, is the manufacture of Plows and other Agricultural Implements

Crops have more to do with the wealth and prosperity of a country than any other class of products. To get good and bounteous crops a very important element is good farming tools.

The builders of Plows and other Tillage Tools, Harrows, Mowers, Reapers and similar and allied lines of Machinery, employ in their construction a great variety of Steel specialties, to the manufacture of which we have given painstaking care. These materials which are of the highest grade are specially suited to the purposes intended.

Following will be found a list of many of these specialties:

Soft Center Plow Steel
Solid Cast Plow Steel
Discs for Drills, Harrows, Cultivators and Plows
Rolling Coulter Blades
Bean Harvester Blades

Disc Blanks
Rolling Coulter Blanks
Disc Scraper Steel
Agricultural Punch and Chisel Steel

Stalk Cutter Knife Steel
Hoe or Grain Drill Point Steel
Weed Cutter Steel
Weed Hook Steel

Ensilage Knife Steel
Surface Cultivator Steel
Rake and Hoe Steel
Straw Cutter Knife Steel

Shin Steel for Moulds and Shares
Ice Plow Steel
Standing Coulter Steel

Road Scraper Blade Steel
Scarifier Tooth Steel
Rooter Steel

Cylinder Tooth Steel
Ledger Plate Steel
Guard Plate Steel
Reaper and Section Steel

REAPER SECTION AND GUARD PLATE STEELS

Over fifty years ago this Company began the manufacture of Reaper Section and Guard Plate Steels for harvesting and mowing machines. The Department reserved for the production of these steels maintains the highest standards of quality, which result in excellent steel, rolled uniformly and sheared accurately. We furnish these grades in Crucible and Open Hearth quality.

LAY STEEL

Hardware and other jobbers have constant call for "Lay" Steel, used by blacksmiths in repairing plow shares. We supply all standard sizes of "La Belle" quality in either hammered, hammer finished or rolled finish.

LA BELLE SOFT CENTER PLOW STEEL

Our Soft Center Plow Steel represents the highest development of the steel maker in producing material which is strongly constructed physically, readily worked by the plow builder and which will give the maximum service under the widest possible variation in conditions of soil and climate.

Particular attention is called to its uniformity in the distribution of the soft center and the hard outside layers, to its uniform hardening qualities and to the fine polish the hardened steel will take.

It is manufactured in Bars, Slabs and Shapes, cut to pattern, for use in the manufacture of Mouldboards, Shares, Landsides or Cultivator Shovels, as well as in special bar form with covered edges used for Landsides and for Slat Plow Mouldboards. We can furnish the latter either in random length bars or with the ends trimmed to pattern.

We are also in position to supply Soft Center Steel in beveled sections for special purposes.

LA BELLE SOLID CAST PLOW STEEL

CRUCIBLE CAST
ANCHOR CAST
ARROW BRAND
KEYSTONE BRAND
CORONA BRAND

These well known brands are in universal use, and are supplied in Bars, Slabs, Cut Shapes and Special Sections.

In these grades we also roll double-beveled Slabs for the manufacture of small plow-shares. The rolled bevel is of such width and angle that the plow-builder is saved the operation and expense of "plating" or beveling the cutting edges of the shares. For certain purposes the use of this Steel is most economical.

We roll Single and Double Beveled Steel for various purposes including: Stalk Cutter Blades, Surfacers, Gopher Blades, Bean Harvester Blades, Road Grader Bits, either in bars or cut to patterns. The use of this Beveled Steel will save implement manufacturers the expense of sharpening.

LA BELLE CUT SHAPES

Each manufacturer of plows and agricultural implements has his own lines of patterns or templets. These vary so much in shape or form and degree of waste or loss in shearing that no classification can be made comprehensive enough to cover the wide range, but a partial list of what are considered "standard" shapes is:

Mouldboards, New Ground
Mouldboards, Regular
Mouldboards, Breaker
Mouldboards, Hillside
Shares, Parallel
Shares, Tapered
Shares, Horned
Shares, Platformed
Shares, "V" Lister
Shares, Solid Lister
Landsides, Parallel
Landsides, Tapered
Frogs or Standards
Fin-Cutters, Cut-Out
Fin-Cutters, Solid
Root Cutters
Center Sweeps
Disc Scrapers
Gopher Blades
Stalk Cutters
Sub Soilers
Potato Digger Shovels
Rudders
Garden Plow Shapes

LA BELLE CUT SHAPES—Continued

Shovels, Bull Tongue Pattern
Shovels, Turn Pattern
Shovels, Mould Pattern
Shovels, "Regular" Single Point
Shovels, "Regular" Double Point
Shovels, Spear Point or Wing
Shovels, Round Point
Corn Planter Runners—Straight
Corn Planter Runners—Curved
Heels for Corn Planter Runners

FROGS AND STANDARDS

In the construction of the modern steel plow there is always a base or "standard" to which the beam and all the wearing or working parts are fastened. The steel in this standard, sometimes called a "Frog", must be of such quality that it may be pressed into intricate forms without cracking, while there must be at the same time sufficient stiffness to retain the shape under tremendous stress and strain.

We supply steel in slabs or cut to shape for this purpose, and can fully recommend it to discriminating users.

SHIN STEEL

It is of importance that the steel used for "shinning", or reinforcing of those parts of mouldboards and shares subject to the hardest wear, should be of such good quality that it will weld readily, harden properly and not crack or "craze" in hardening or in subsequent use in the field. The manufacturer of Soft Center Plow Steel is well qualified to develop these essential features, and to the users of Soft Center Steel, we recommend, for Mouldboard and Share Shins, our special brands of

Crucible Analysis Shin Steel
Anchor Cast Shin Steel

CYLINDER TOOTH STEEL

Builders of threshing machines require steel of superior quality for making what are variously known as cylinder teeth, thresher spikes or thresher teeth. Our "La Belle" Cylinder Tooth Steel,

supplied in rounds, squares and flats as required, is designed to meet the most exacting conditions. It forges easily, is tough and strong, and hardens readily.

ENSILAGE CUTTER BAR STEEL

Supplied in flat and beveled shapes, as required, in both Soft Center and Solid Cast Plow Steel grades in multiple bars or sheared to short lengths.

HOE POINT OR GRAIN DRILL STEEL

Accurately rolled to standard double-beveled sections (or in special forms to specifications). Supplied in bars (random lengths or multiples) or sheared to pattern with either single or double point.

STALK CUTTER KNIFE STEEL

The vital feature of a corn stalk cutter is the cutting edge or knife. Our products for this purpose may be depended upon to give the maximum of service, owing to their toughness and strength. They are supplied in all sizes of flats, or single and double bevels as called for.

SURFACE CULTIVATOR STEEL

In recent years implement manufacturers have introduced what are known as Surface Cultivators, as distinguished from Shovel Cultivators. Quality is of the greatest importance in the beveled blades which do the actual cultivating. To meet this condition we offer the trade steels which are "Special" in the sense that they are hard, tough and enduring. We produce them in all standard beveled sections from either Soft Center or Solid Cast Plow Steels, as well as cut to pattern.

ROLLING COULTER BLADES

A special department is devoted to the manufacture of Rolling Coulter Blades. These blades are punched to the buyer's templets, and are polished and finished ready for assembling. For shipment, they are carefully coated with a rust-resisting composition, and are packed in boxes or kegs.

The principal sizes are 10 inches to 26 inches diameter by $\frac{1}{8}$ inch to $\frac{3}{16}$ inch thick, varying in thicknesses according to diameters and requirements.

DISCS FOR AGRICULTURAL IMPLEMENTS

Concave Discs have been adapted to many kinds of drills, harrows, plows and cultivators. They were first used in disc harrows, which have superseded, to a large extent, spike-tooth or spring-tooth harrows. We have kept pace with this development and have equipment and facilities for manufacturing all kinds and shapes of Discs, varying in thickness and concavities.

In their production, we use steel of such temper and quality as requirements have shown to be best suited to the purpose. Years of experience enable us to supply Discs requiring the minimum of labor and cost to grind and polish to a satisfactory finish.

SIZES OF DISCS

Our equipment for the manufacture of Discs of all standard sizes is most complete, the range of sizes being from 8 inches to 28 inches inclusive, with thickness varying with the diameters so as to provide ample strength in severe use.

In designing new machines, we recommend to our customers, that such portions of the specifications as pertain to the Disc equipment be submitted to us before the final decision is made. This will save the buyer time and expense, as we can usually suggest slight changes in the concavities, thicknesses and punching, which can be adapted to standard equipment.

BEVELS OF DISCS

On account of varying soils in different localities, there is call for bevels of discs to meet such conditions, and the builders of machinery requiring discs are requested to correspond with us regarding this important feature.

PUNCHING OF DISCS

Our equipment for punching is full and complete. These tools provide for square and round center holes of various sizes, as well as combinations of such center holes with rivet and bolt holes on circles of different radii. With orders for punching differing from standard practice, it is advisable to send us a blue-print or sketch showing the exact size, spacing and location of the various holes. It

is also well to send one of the hubs to which the discs will be riveted or bolted in assembling, to be used as a check on the finished product before shipment.

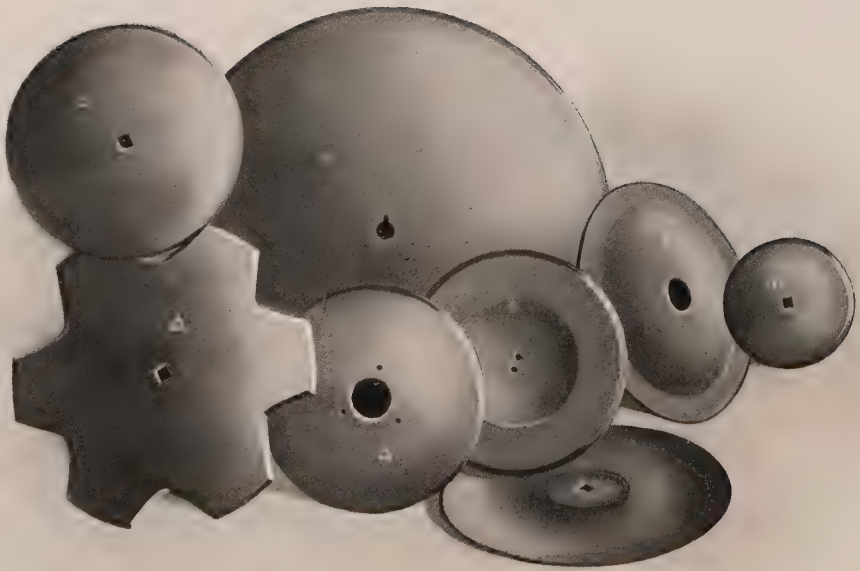
CONCAVITIES OF DISCS

The following are "standard" concavities of discs:

Diameter	Concavities			Diameter	Concavities		
8″	9/32″	19/32″		16″	1 3/8″	1 1/2″	1 5/8″
					2″		
10″	9/16″	3/4″	1 1/8″	18″	1 1/2″	1 3/4″	1 13/16″
					1 15/16″	2 3/8″	2 5/8″
11″	7/16″	1 3/16″		20″	1 15/16″	2 1/2″	3″
12″	1/4″	7/8″	1 1/4″	23″	2 7/8″	3 3/4″	
13″	11/16″	13/16″	7/8″	24″	3 3/4″	3 1/2″	Hancock
14″	3/8″	3/4″	7/8″	26″	4″	4 1/2″	
	1 1/32″	1 3/16″	1 1/2″				
15″	1″	1 3/8″		28″	5 3/8″		

In addition to the standard concavities listed we can furnish "special" concavities where so required.

NOTE.—Inquirers should state fully such features as diameter, thickness, concavity, width of bevel, size and shape of center hole and number, size, shape and location of rivet holes.



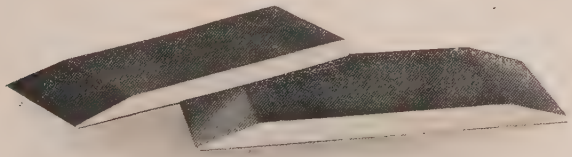
AGRICULTURAL DISCS

STEEL FOR ROAD MAKING MACHINERY

ROAD SCRAPER BIT STEEL

Our products for the vital wearing parts of road making machinery are recognized as superior to all other steels. Their use enables the machine builder to extend a much broader guarantee than is usual. The stock used is most carefully selected and graded. The steel is tough and dense, and of such hardness that extreme durability is assured. We are able to supply our customers with Carbon Steel, or Alloy Steel according to their needs.

We are in position to supply all standard widths, thicknesses and bevels (either single or double), accurately rolled and straight.



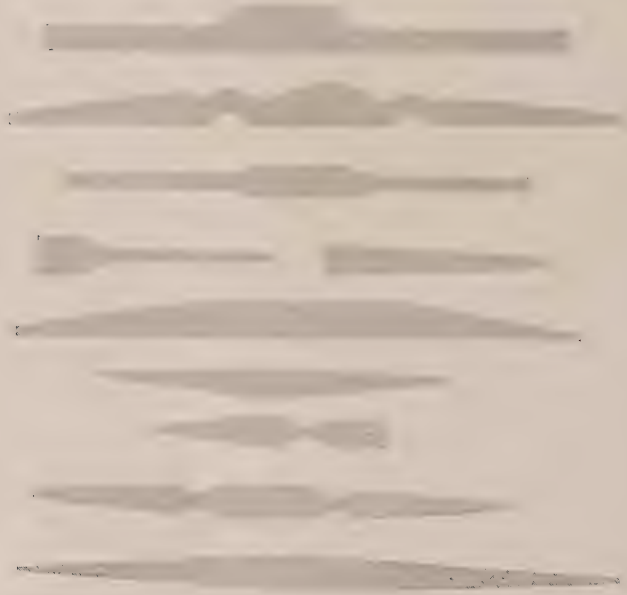
SCARIFIER TOOTH STEEL AND ROOTER STEEL

The Scarifier Tooth Steel and the Rooter Steel are called upon to do the hardest work and stand the severest shocks of any of the road builders' tools and therefore, must be made of a steel that is hard enough to wear well and at the same time be tough and strong. The steels we have developed for these purposes and which we sell by these names are the results of thorough tests on our part and by our customers. The increasing demand for them indicates that they fully meet the requirements.

GARDEN IMPLEMENT STEELS

Steels for the following purposes are supplied by us in all of the standard sections required by the trade, such as:

Bush and Grass Hook	Pruning Shears
Fork	Rake
Grass Shears	Reaper Hook
Grape Shears	Solid Scythe
Hedge Shears	Weed Cutter
Hoe	Scythe Edge

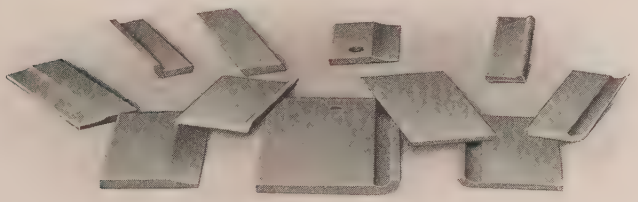


LAWN MOWER STEEL

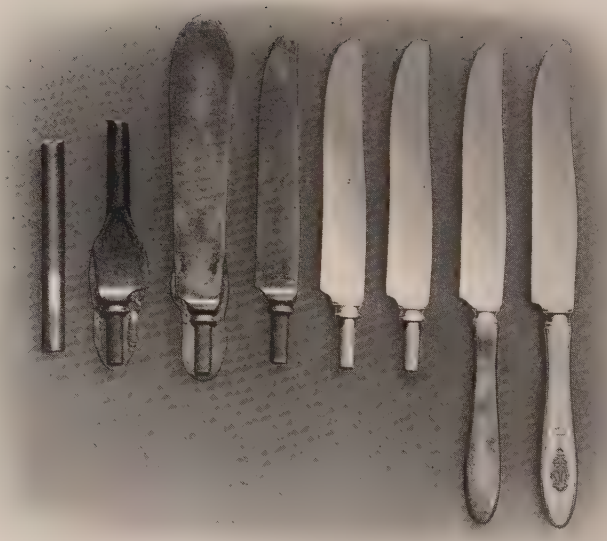
The cutting parts of a lawn mower, probably the most abused of all garden implements, require steel which is dependable. The manufacturer of the mower can build a machine which is perfect in adjustment and action, but the vital feature—the cutting mechanism—is such that every other detail becomes of secondary importance.

CUTTER BAR STEEL
REEL OR WIPER KNIFE STEEL
PAWL STEEL

These steels are furnished in all special shapes and qualities.



We also furnish plain, flat section Cutter Bar Steel, cold rolled and tempered, ready for service.



THE EVOLUTION OF A TABLE KNIFE

CUTLERY STEEL

CUTLERY STEEL

STAINLESS—CARBON

Our Cutlery Steels are recognized as the highest standard and are used by the most reliable makers of Cutlery. It is essential that steel for these purposes be accurately rolled and made from carefully prepared stock. Backed by the experience of many years in the manufacture of these various brands, we are in a position to offer a complete range of grades in flats, rounds, squares, ovals, sheets, single and double bevel bars, as well as numerous special sections. A few of the leading purposes for which our Cutlery grades are being satisfactorily used are:

Pocket Cutlery

- Blades
- Back Spring
- Bolster Steel

Table Cutlery

- Carving Knives and Forks
- Carver Guard
- Double Shear Steel
- Pie Servers
- Solid Blade and Fork
- Spoon Steel
- Flat Table Blade and Fork
- Double Bevel Table Blade and Fork
- Fruit Knives
- Steel for Steels

Kitchen Cutlery

- Apple Parer Knife
- Banana Knife
- Bread Knife
- Butcher Knife
- Canning Knife
- Can Opener Steel
- Cheese Cutter Knife
- Cleaver Steel
- Curd Knife
- Kraut Cutter Knife
- Meat Choppers
- Oyster Knife
- Paring Knife
- Slaw Cutter Knife
- Slicer Knife
- Spatula Steel

CUTLERY STEEL—Continued

Miscellaneous

Bamboo Cutters	Hunting Knife
Belt Knife	Knife Scratchers
Bolo Knife	Machette Blades
Broom Knife	Nut Cracker Steel
Cane Knife	Paint Scraper
Clipper Steel	Pallet Knife
Corn Knife	Putty Knife
Farrier Knife	Rubber Knife
Fodder Knife	Scissor and Shear Steels
Grafting Knife	Shoe Knife
Grainer Combs	Straw Cutter Knife
Hay Knife	Surgical Knife
Hog Knife	Tobacco Cutter Knife

Veneer Knife

Stainless Steel is used in large quantities for various Cutlery purposes. This grade is described in detail in another section of the catalogue, see pages 173 to 175 inclusive.

CUTLERY STEEL CLASSIFICATION OF EXTRAS

CARBON STEELS

DOUBLE BEVEL

$1\frac{15}{16}$″ and wider x 17 gauge center and heavier	Base
$1\frac{15}{16}$″ and wider x 18 gauge center	½c. per lb.
$1\frac{15}{16}$″ and wider x 19 gauge center	1c. per lb.
$1\frac{3}{8}$″ to $1\frac{15}{16}$″ wide x 17 gauge center and heavier	½c. per lb.
$1\frac{3}{8}$″ to $1\frac{15}{16}$″ wide x 18 gauge center	1c. per lb.
$1\frac{3}{8}$″ to $1\frac{15}{16}$″ wide x 19 gauge center	1½c. per lb.
$1\frac{1}{4}$ to $1\frac{3}{8}$″ wide x 17 gauge center and heavier	1½c. per lb.
Over $4\frac{1}{2}$″ to 5″ wide	½c. per lb.
5″ to $5\frac{1}{2}$″ wide incl.	1c. per lb.

ROLLED FLAT BARS lighter than 14 gauge—½c. per lb. per gauge.

ROUNDS AND SQUARES:—$\frac{3}{8}$″ and larger—Base.

SHEET STEEL:—Our Standard Extras for Carbon Sheet Steel apply—see page 80.

Classification of Extras for Stainless Steel will be furnished on application.

AXE STEEL

HACHET STEEL

MACHINE GUN AND SMOKELESS RIFLE BARREL

REVOLVER CYLINDER STEEL

SHOT GUN BARREL

SKATE STEEL

SAFETY TREAD STEEL

TEXTILE MACHINERY STEEL

AND

OTHER MISCELLANEOUS STEELS

AXE STEEL

Made in the overcoat and rectangular sections. Black Diamond Axe Bit Steel has been the accepted standard for over half a century. It is of the highest quality and is accurate as to size.

We furnish the shapes illustrated below in Alloy as well as Straight Carbon Steels.

Overcoat Axe Steel

HATCHET STEEL

Supplied in the regular line of flats and squares, as well as many special sections, such as the "Scarfed Hatchet" used by makers of edged tools. Hatchet Steel is furnished in Alloy and Straight Carbon grades.

EYE PIN STEEL for Forming the Eyes. We are prepared to furnish a broad range of sizes of Eye Pin Steel, both single and double bevel.

MACHINE GUN AND SMOKELESS RIFLE BARREL REVOLVER CYLINDER STEEL SHOT GUN BARREL

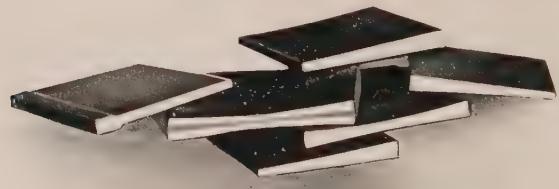
Steels for these purposes are furnished in both Carbon and Alloy grades, in natural and heat treated condition. They are manufactured with intimate knowledge of ballistic requirements and can be furnished in a condition best suited to the individual requirements of the manufacturer and of the component part involved. We have learned, from many years of experience, the requirements necessary in their machining and drilling qualities commensurate with the physical properties involved.

In addition to the foregoing specialties, we manufacture a carefully developed line of:

Receiver Steel
Lock Work Steel and
Steels for similar parts.

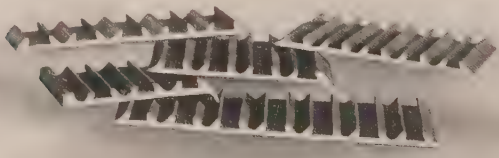
SKATE STEEL

Steel for this purpose is supplied by us in all the standard sizes and grades in hot and cold rolled bars, strips sheared from sheets, as well as the special sections such as Flange Runner and single and double bevel. We furnish all these items in Crucible, Electric and Special Open Hearth, in both Alloy and Straight Carbon grades.



SAFETY TREAD STEEL

This steel is especially designed to meet all the requirements necessary to prevent slipping on stairways, doorways, elevator entrances, fire, engine and boiler rooms.



SPINDLE AND ROLLER STEEL FOR TEXTILE MACHINERY

Used in the manufacture of cotton, woolen, wool and silk mill machinery.

These are specialties produced to meet the most exacting conditions of the Textile trades.

For a long period we have specialized on these grades with such results that they are now the standards of the largest and best known Textile Machinery manufacturers.

Furnished in hot rolled bars, accurate to size, free from seams or defects.

These steels are used for the following purposes:

Roving and Spindle Rollers
Card Rollers
Cop Spindles
Mule Spindles

In addition, we produce special steels for the particular requirements of:

Spinning Rings
Bobbin Spindles
Tips
Shuttle Springs
Flyer Steel

NUT LOCK STEEL

Steel for this purpose is furnished by us in all the standard sizes of rounds, squares and flats as well as keystone and ribbed sections in both coils and bars. We supply it to meet the various specifications of our customers in Alloy and Carbon Steels.

TONG REIN STEEL

For sheet and plate mill Tongs - furnished in bars and forged to shape.

EXTRAS ON FORGED TONG REINS

10 lbs. and over	Base
8 lbs. to 10 lbs.	1c. lb. extra
5 lbs. to 8 lbs.	3c. lb. extra
3 lbs. to 5 lbs.	5c. lb. extra
1 lb. to 3 lbs.	7c. lb. extra
Tongs weighing under 1 lb.	45c. net.

MISCELLANEOUS STEELS

We are prepared to supply promptly, Crucible, Electric and high grade Open Hearth Steel in all standard sizes and shapes and in many special sections, for use in the manufacture of tools, implements, etc. for every known purpose, some of which we list below:

Adzes
Agricultural Chisels
Agricultural Punches
Anvil Arbors
Anvil Blocks
Anvil Facing
Auger Bits
Augers (Mine)
Awls
Axes

Band Knives
Bending Straps
Bolt Clippers
Brace and Bit Jaws
Brake Bands
Bush Hammers
Butcher Knives

Cant Hooks
Carpenters' Squares
Center Punches
Chisels (Hand)
Chisels (Pneumatic)
Chuck Jaws
Claw Bars
Corkscrews
Concrete Reinforcing Bars

Digging Bars
Draw Knives
Dredge Bucket Teeth
Drift pins

Emery Wheel Cutters
Emery Wheel Dressers

Files
Fly Bars
Forks
Furnace Bars

Granite Wedges
Grass Hooks
Grass Shears

Hammers
Harrow Teeth
Hatchets
Hoes
Hog Knives
Horse Rakes

Ice Chisels
Ice Picks
Ice Plows

Mattocks
Mine Bits

Nail Pullers

Paint Scrapers
Pene Hammers
Picks (Coal)
Picks (Quarry)
Pinch Bars
Pipe Cutters
Pipe Wrenches
Plane Bits
Plane Caps
Pliers

MISCELLANEOUS STEELS—Continued

Plasterers' Tools
Pulverizer Hammers
Putty Knives

Rakes
Rivets
Rollers

Saw Teeth
Scraper Knives
Screw Drivers
Scythes
Section (Reaper)
Sheep Shears
Shims
Skates
Skidding Tongs
Sledges
Spikes
Straw Cutter Knives

Tack Claws
Tong Bits
Trowels
Try Squares

Vise Jaws
Vises

Washers
Wedges
Wood-working Chisels
Wood-working Knives
Wrenches

We solicit your inquiries for steel used for above purposes or similar requirements not specifically mentioned above.

ELECTRIC MELTING FURNACE

COLD MELT ELECTRIC FURNACE CARBON STEELS

Our Cold Melt Electric Furnace Straight Carbon Steels fill an ever increasing need for carbon steels of the very highest character, particularly as regards freedom from segregation and inclusions. They represent the highest attainment in carbon steel melting. These steels may be furnished to various analyses to meet the needs of our customers and we recommend them to automotive and other manufacturers for the construction of vital parts demanding a steel of very high character. These steels are manufactured by us in small units, which permits us to give them the closest care through all stages of manufacture.

We have the largest electric furnace capacity for cold melting in the United States, which enables us to take care of the increasing demands for this very high grade carbon steel product.

BRINELL MACHINE FOR DETERMINING
HARDNESS VALUES

SAFE, VAULT AND JAIL STEEL
BULLET PROOF STEEL

SAFE, VAULT AND JAIL STEEL

Five-Ply Tool-Proof Chrome Steel Plates require extensive fabrication by specialists in bank vault and safe construction before assembling; therefore our activities are devoted to calling the attention of bankers to the merits of five-ply construction employing our

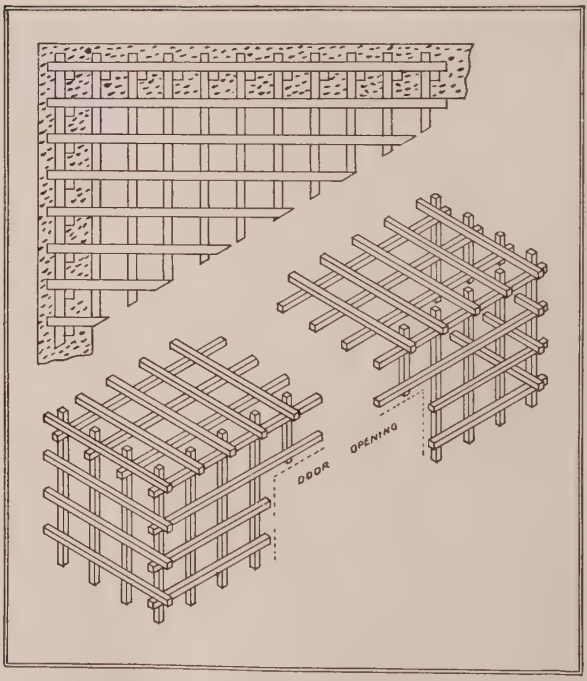
steel and recommending to them responsible builders of safe and vault equipment. For estimates on vault or safe work of any kind, communicate with such builders and specify "Laminated Five-Ply Tool-Proof Chrome Steel, made by Crucible Steel Company of America".

FIVE-PLY TOOL-PROOF BARS

HARDENED

Many banks including Federal Reserve Banks, have installed vaults with 3-inch tool-proof linings, and added to the security of such installations by protecting the concrete walls with a grille or network of Five-Ply reinforcement bars. We are prepared to supply Hardened laminated five-ply tool-proof Chrome Steel Bars, straightened and cut to lengths. This protection is also extensively employed in banks in the smaller cities and towns, where a burglar-proof safe is depended upon for protection of money and valuable papers. The usual method of assembling these bars is known as the "cross-grille", illustrated on page 148, the customary spacing being either 3 inches or 4 inches center to center, vertically and laterally in the walls and horizontally and transversely in the ceiling and floor. This type of vault can be erected by the class of labor available in the force of any contractor or builder and does not require highly skilled workmen, the bars being set up in the wooden concrete forms with wire ties at the corners and at such intervals as to support the grille while the concrete is being poured.

The owner must, of course, provide a suitable door and door frame which is usually installed by representatives of the maker.



TYPICAL INSTALLATION OF HARDENED BARS FOR BANK VAULT REINFORCEMENT

FIVE-PLY TOOL-PROOF SAFE AND VAULT STEEL

The accepted type of construction for a burglar-proof vault is a brick or concrete shell within which is placed a built-up lining composed of alternate layers of soft steel plates and laminated Five-Ply Tool-Proof Chrome Steel Plates. Door frame and door are made of similar materials and the door is provided with suitable time-locking devices.

We manufacture laminated steel in both plate and bar form, composed of alternate layers of soft and Chrome Steel, so placed in the section that it is impossible to drill, saw or file beyond the soft steel envelope. When the plate or bar is heated to the proper temperature and quenched in cold water, the chrome steel layers become file hard and tool proof while the soft steel remains in its natural

SAFE DEPOSIT VAULT BUILT WITH OUR FIVE-PLY BURGLAR-PROOF STEEL

ductile condition giving the greatest possible degree of strength, toughness and resistance to deflection, thus rendering the vault or safe highly resistant to dynamite charges or mob violence.

SEVEN-PLY SCREW STEEL

This steel is used in the manufacture of screws for assembling the walls and doors of burglar-proof vaults and also for the manufacture of spindles in the locking devices for vaults and safes. Furnished in all commercial sizes of rounds.

BULLET PROOF STEEL

The protection of bank funds and securities like a chain, is no stronger than the weakest link and that bank which does not adequately protect its property during the transportation to another institution has a very weak link in its chain. This weakness has been the subject of serious thought on the part of bankers because some of the heaviest losses in recent years have been due to the robbing of messengers. This has resulted in the demand for a truck suitably protected by armour which will not only withstand the impact of a bullet, but at the same time be of such light weight as not to seriously reduce the carrying capacity of the truck.

Prior to and during the World War, the Crucible Steel Company of America developed to a high degree their Bullet Proof Steel used for protecting the men operating the field artillery, from the bullets of sharp shooters and machine guns. Therefore, it was not a difficult matter to adapt this steel to use on motor trucks when the demand arose.

We manufacture this steel in any thickness desired, but as the bandits have all types of firearms at their command, we recommend the use of plates not less than ¼ inch thick which will withstand rifle as well as revolver fire.

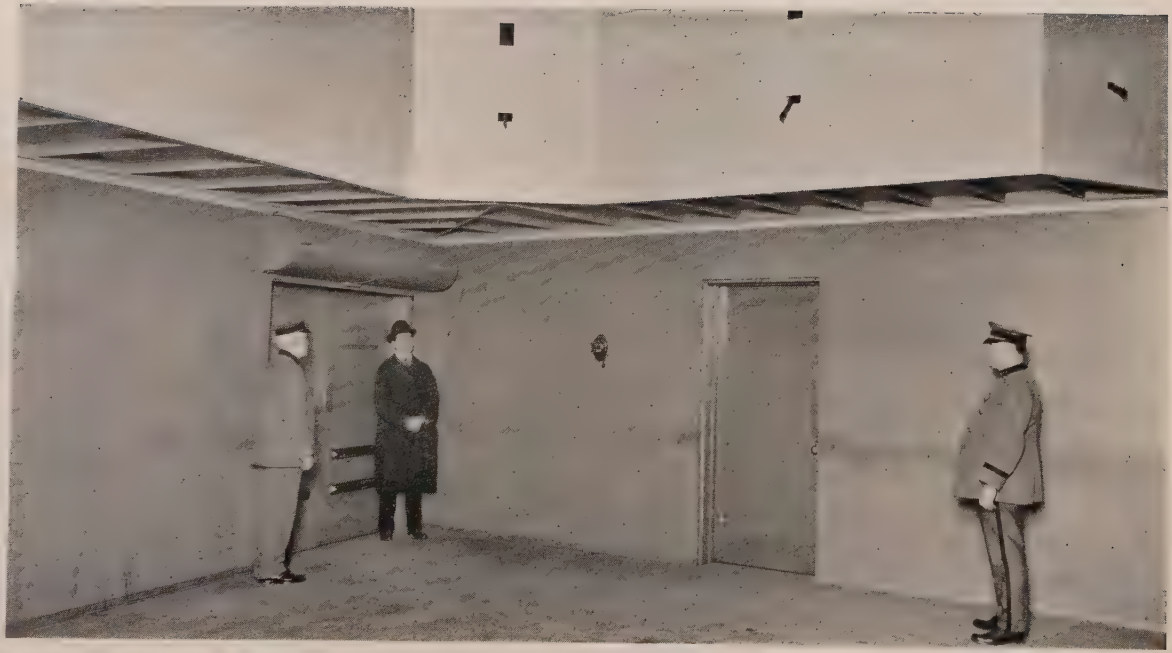
This steel is being used in steadily increasing quantities for protecting motor vehicles and railroad cars for carrying mail and large sums of money.

Federal, State and Municipal authorities as well as Financial Institutions and Express Companies are rapidly adopting vehicles protected by this material for the safeguarding of their employees and property against holdups and robberies.

The Federal Reserve Bank of New York, as an added protection to that institution, had a bullet proof gallery built in their new bank building. Other banking institutions are having their tellers' cages protected by our Bullet Proof Steel.

This steel takes a fine finish and will harmonize well with the interior decorations of a bank, at the same time providing protection to the employees.

We invite correspondence from bankers and others interested in this form of protection.

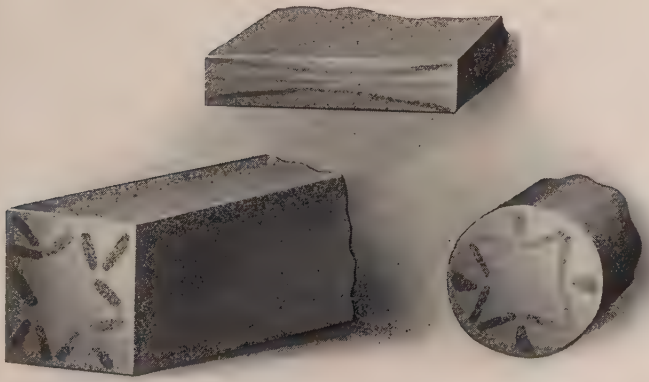


BULLET PROOF GALLERY
Federal Reserve Bank of New York

FIVE-PLY CHROME JAIL STEEL PLATES AND BARS

This material is manufactured in practically the same manner as safe and vault steel and should be treated for hardening in the same way. The construction of jail and prison work is a highly specialized business, and prospective builders should communicate

TRADE JB MARK



with one of the organizations which is fitted for the fabrication of such work. This steel is specified by State, County and Municipal officials for the construction of prisons and jails in which absolute security is desired, and it has been employed in building prisons (of which the names will be supplied on request) which are considered models. There is no known instance where confined prisoners have escaped by cutting through genuine Five-Ply Tool-Proof Chrome Steel construction.

PRISON CORRIDOR CONSTRUCTED WITH OUR FIVE-PLY JAIL-BAR STEEL

ALLOY STEELS
FOR
SPECIAL PURPOSES

NON-CORROSIVE AND HEAT RESISTING STEELS

REZISTAL STAINLESS IRON — ATHA 2600 STAINLESS STEEL — "NON-COR" FERRO-NICKELS

These steels are offered to all those whose needs have not been met, whose dreams have not come true as to the realization of hopes for new processes, better apparatus, improved yields, increased efficiency and decreased costs simply because the right materials were not at hand. A study of the following data may prove to you that the erstwhile unattainable is now attainable.

The Rezistal Alloys, including "Atha's No. 2600," herein described, possess many unusual and remarkable properties never before available in either ferrous or non-ferrous materials. They are the product of many years of untiring research and our laboratory tests have been amply confirmed and our own hopes fully justified by hundreds of industrial applications. Beside the Rezistal Steels, we are also licensed manufacturers of Stainless Steel and Stainless Iron. We thus cover the entire field of non-corrosive steels more thoroughly than any other manufacturer.

There is a very general interest in the use of materials of a non-corrosive character. This Company is the only one that fully covers the range of possibilities in meeting the individual problems that arise in this field. These products, in general, may be classified in two groups.

First, those which can be hardened or heat treated, similar to carbon and alloy steels. This group includes primarily Stainless Iron and Stainless Steel, by which terms we refer to the alloys with 9 to 16% chromium. Stainless Steels are ordinarily made of about .30 carbon, and by general consent Stainless Iron is considered as represented by the product containing .12 carbon and below. Other carbons may be used in special cases in connection with the Stainless Steel product. Stainless Iron does not have to be heat treated, although both its physical properties and its stainlessness are improved by so doing. Notwithstanding this very low content of carbon, it responds very nicely to hardening and drawing so that high physical properties may be produced where considerable strength is needed or desired. Similarly, if still greater strength is

required, Stainless Steel may be used after hardening and drawing the temper to various degrees, according to the strength desired and in this case it still retains its stainlessness to a very great degree up to drawing temperatures of 900° to 1000° F.

The second group of non-corrosive products are for the most part chrome-nickel steels with high content of both chromium and nickel and sometimes with small additions of other elements to produce particular results. A high silicon content has been found to be very useful in this class of steels, and this is the distinct feature of Rezistal that sets it apart from several other products of a distinctly lower quality.

The second group of steels, which cannot be hardened, includes Atha's No. 2600 and the various types of Rezistal Steels. Atha's No. 2600 is a Rezistal Steel and is covered by the range of the C. M. Johnson patents. It happened to have been developed at our Atha Works and has been designated as a special product while in reality it is a Rezistal Steel.

While the tensile properties of the high chrome-nickel-silicon steels are not especially high, they retain their physical properties to a very great extent at elevated temperatures. In this respect they differ sharply from the ordinary carbon and alloy steels which weaken very rapidly at high heats. A recent test on No. 2600 showed a yield point of 80,000 lbs. when the test was conducted at a temperature of 1000° F. Fatigue, torsion and tensile tests made on steels similar to No. 2600 between the range of 1200° to 1600° F. showed that the physical properties at a red heat are decidedly superior to those of any other steel including the ordinary alloys, high speed steel, silicon-chrome, etc. One of the Rezistals will resist serious scaling at a temperature as high as 2200° F. This combination of properties makes the chrome-nickel-silicon group of special interest for application where high temperatures are required.

REZISTAL ALLOYS

GENERAL:—These are austenitic steels of the silicon-chrome-nickel type, manufactured exclusively by the Crucible Steel Company of America under U. S. Patents Nos. 1,420,708 and 1,420,707. Rezistal* resulted from researches begun during the war period to meet a demand then existing for alloys to withstand high temperatures and to resist corrosion under the widest possible conditions as to the corrosive agent that might be involved.

*Trade Mark, Reg. U. S. Pat. Off.

The public is not familiar with the properties of austenitic steels, which are in some respects the very antithesis of pearlytic steels. In fact, the name "Rezistal" was adopted because of these distinguishing characteristics—they do not rust or corrode; they may not be magnetized; they are highly resistant to the passage of the electric current and to the cutting action of the oxy-acetylene torch; they cannot be hardened by quenching; they become tougher at high quenching temperatures than at normal quenching temperatures; they are not embrittled by cold, and to—80° F. at least become increasingly more resistant to shock; they do not scale upon exposure to high temperatures from 1800° to 2200° F. and the appropriate type resists perfectly almost all of the strongest mineral and organic acids, also alkalies and many molten metals and salts. Research has been unremitting since these products were first shown and our products have undergone improvements as laboratory tests were confirmed by practical experience in the industrial world. We may now, with considerable assurance and confidence, discuss with you your problems. Prices and Classification of Extras furnished on application.

MECHANICAL PROPERTIES OF REZISTAL

In these highly alloyed products carbon is not a great factor in determining the tensile properties between .20 and .60 per centum. The initial properties are the result of the alloy content and the temperature of finishing under the hammer or in the rolls. The speed and amount of the final reduction also influence the tensile properties. In general, the highest elastic and tensile values are found in the material "as rolled" or "natural condition." The natural condition shows properties about as follows:

Yield Point	80,000–110,000 Lbs. sq. in.
Tensile Strength	100,000–150,000 Lbs. sq. in.
Elongation in 2 in	35%–20%
Reduction in Area	50%–30%
Brinell	225–300

The specific gravity of the Rezistal Steels is from 10 to 12% less than copper, nickel or cupro-nickel alloys.

Any subsequent annealing, normalizing or quenching reduces the yield point, tensile strength and Brinell, while greatly increasing the ductility and shock resistance. Rezistal alloys are tough even in the natural condition (18–30 foot pounds) while after heat treating they acquire remarkable resistance to shock (50–95 foot pounds).

In this respect they differ sharply from the straight high chrome steels (17–30% Cr.) which display extreme shock-brittleness in almost every condition (1–3 foot pounds). Rezistal Steels cannot be hardened by any kind of quenching, on the other hand they are readily softened by quenching, improving the machining and cold-forming qualities. They may be greatly hardened by cold-rolling and cold-drawing, which simultaneously greatly increases the tensile strength and yield point.

MECHANICAL PROPERTIES AT HIGH TEMPERATURES

The weakness of carbon and ordinary alloy steels at elevated temperatures is well known. While Rezistal Steels are not as strong at ordinary temperatures as many of the structural alloys, they have the property of "holding on" very much better at elevated temperatures than other steels, not excepting high speed steel. For example, a steel of 20.00% Nickel and 12.00% Chrome broke at 34,100 lbs. at 1650° F., or nearly double the strength of high speed steel and stainless steel at the same temperature and three to four times as strong as several other alloys not containing nickel.

Other tests of Rezistal at high temperatures show as follows:

	Tensile Strength	Elongation	Reduction
700° F.....	85,700 per sq. in.	28.5%	39.6%
700° F.....	88,200 per sq. in.	31.0	42.8
1000° F.....	100,300 per sq. in.	24.0	30.0
1292° F.....	71,470 per sq. in.	20.	24.7
1472° F.....	44,900 per sq. in.	28.5	62.8
1760° F.....	21,395 per sq. in.	37.5	82.4

The above are typical tests at random as made by our customers and ourselves on different types of Rezistal. They are very convincing as to the strength of this material at such temperatures as are met with in steam-valve, turbine, oil-distillation, and exhaust-valve applications.

FATIGUE RESISTANCE

Steels of Rezistal type have been studied by Prof. H. F. Moore, Dr. D. J. McAdam, Jr., and others. They show very good resistance and seem to behave like the ordinary alloy steels of similar

physical properties. Their endurance limits for ten million cycles in the rotating cantilever machine, seem to be close to one-half the tensile strength or, say, 50,000 to 65,000. Furthermore, they seem to retain this property at high temperature operations, in about the same proportion that they retain their strength relative to all other materials. From the limited data available on this subject we can at least say that they retain their fatigue resisting properties, as well as their strength, hardness and rigidity remarkably well at elevated temperatures, and are particularly safe engineering materials. This broad presentation of the mechanical characteristics of Rezistal Steels shows that they possess great value and interest for the construction of apparatus, machinery and special equipment for use under high temperatures.

CHEMICAL PROPERTIES

RESISTANCE TO OXIDATION, SCALING, ETC.—We have noted how well these steels are adapted to high temperature duty. This, however, must be further predicated upon their non-destructive properties at high temperatures. They are totally free from rust, tarnish, or scaling at atmospheric temperatures, and also resist salt-water, or spray exceptionally well. In fact, "Atha's 2600" was independently developed for marine use such as periscope tubes, submarine parts, etc.

Under active oxidizing conditions as in valves, enamelling racks, furnace bottom plates, etc., they resist temperatures as high as 2200° F. and will stand higher temperatures for short periods without heavy scaling. One grade lost no weight after five hours at 1600° F. while under identical conditions, steels such as nickel, silico-manganese, chrome-silicon and stainless lost from .41 to 2.76%. Another test of Rezistal after thirty-five hours of heating in an oxidizing atmosphere, all above 1650° F. and ending with seven hours at 2050° F. produced no detachable scale. Three samples heated for ninety minutes to 2200° F. in the oxidizing flame of a gas muffle showed a maximum loss in any sample of 1.5 mgms. per sq. in. Under similar conditions pure nickel, monel metal and high chrome steels lost from 15.0 to 520 mgms. per sq. in., thus showing a 10 to 1 advantage over the best of them. It is plain, therefore, that in mechanical properties and resistance to oxidation and scaling, Rezistal Steels offer exceptionally good, and probably unequalled qualities.

RESISTANCE TO ACIDS AND SALTS:—It is in this particular field that most of our research has been performed to produce steels proof against practically every commercial acid. No one composition fills every requirement, but by patient study we have determined the most suitable mixture for many acids, and this work is still going on, for the field is a broad one to cover.

In hot nitric acid, 50%, Rezistal lost 1.02 mgms. per sq. in., but on second immersion the loss was only 0.01 mgm. and was not discolored or etched and neither was the acid discolored. The same behavior was noted when tested with 2% sulphurous acid; there is some attack and loss of weight upon first immersion while with a second immersion it is almost unattacked. With sulphur dioxide gas passed through hot water the mixture of steam and sulphurous acid caused a loss of weight, after four hours, of 1.7 mgms. per sq. in. with "Atha's 2600," 7.0 mgms. with monel metal and 25.3 mgms. with soft steel. A similar test with hydrogen sulphide and steam showed no loss or discoloration with "Atha's 2600," 1.7 mgms. with monel and 6.3 mgms. with soft steel.

Sulphuric acid in 5, 10 and 20% strengths attacks Rezistal slightly but only about one-half of one per cent. as readily as it attacks Stainless Iron or soft steel. However, in mine waters where the dilute sulphuric acid is accompanied by ferric iron salts, Rezistal is free from attack, even after very long exposures, as was shown by exhaustive investigations by the Bureau of Mines, and also by actual service tests for over two years of a compressor piston, cooled with mine water. To lactic, gallic, citric, glacial, acetic, salicylic and phosphoric acid, Rezistal is proof in the cold and hot, with weak or concentrated acids, with the single exception of phosphoric acid, hot, to which it is nearly proof. It is also proof to potash alum, mercuric chloride sterilizing solution, epsom salts and "developing solution." One grade seems proof to fused potassium cyanide, at 1650° F. showing a slight increase in weight upon the first fusion but remaining fixed in weight upon subsequent fusions. It is resistant to molten lead, brass and several other metals.

Experiments at the Fixed Nitrogen Research Laboratory, Department of Agriculture, showed that hot reducing ammonia gases produced rapid disintegration of all metals tried, with the single exception of Rezistal. The other metals all failed by intergranular fissuring.

The elements of time, temperature, pressure and nature of the corrosive agent—pure or mixed—all enter into the problem of corro-

sion resistance, but we have said enough in regard to the remarkable resistance of Rezistal to many of the commoner reagents and chemicals to show the wide field of usefulness that it offers.

MISCELLANEOUS PROPERTIES:—Not only in heat and chemical resistance but because of many interesting physical properties does this material fill a unique position.

COEFFICIENT OF EXPANSION:—Embraced within the series are alloys of extremely low (approaching zero) and also high coefficient of expansion, for example,

20° to 300° C.	0.0000163
300° to 600° C.	0.0000180
600° to 900° C.	0.0000200

A combination of two alloys of respectively low and high expansion is suggested for thermostatic use.

ELECTRICAL CONDUCTIVITY:—A specific resistance of from 500 to 560 ohms per mil-foot may be expected. The material showing 560 ohms resistance shows an average temperature of coefficient of 0.000522 per degree C. between 0° and 538° C., and 0.000243 per degree C. between 538° C. and 982° C. Coupled with its resistance to scaling, the material is suitable for resistance coils and grids, electric furnaces, etc., where the temperatures of operation are not too high.

COEFFICIENT OF ELASTICITY:—In one grade of Rezistal we believe from preliminary experiments that the elastic coefficient, for ordinary temperature ranges is very low. Its use in watch and clock parts, synchronizing tuning forks, etc., is indicated.

MAGNETIC PROPERTIES:—All grades are essentially non-magnetic, the permeability for a magnetizing field of H=300, is between 1.02 and 2.5. Like other austenitic steels some of the grades become very slightly magnetic by prolonged annealing at say, 1300° F. but lose their susceptibility at high temperatures. In this respect Rezistal resembles Manganese Steel, also in increasing its magnetic susceptibility under stress as in cold drawing. Rezistal differs from 25% Nickel Steel in that it does not become magnetic after long immersion in liquid air. It differs also from most materials as it does not become brittle by that treatment. In fact, it may be described as *tough* at all temperatures between —185° C. to +1200° C. Its use in ice and liquid air machines has been practically demonstrated and as a container for liquid air it could scarcely be surpassed.

ANNEALING FOR MACHINING:—Rezistal Steels are not readily machinable in their natural condition. They are not successfully sawed with the ordinary hack-saw. A thin metal slitting saw of high speed steel cuts them readily; a friction disc or thin carborundum wheel may also be used. However, they may be annealed in the ordinary method by heating them thoroughly to 1560° F. (850° C.) followed by slow cooling in the furnace. In the annealed condition Rezistal may be machined, drilled or milled readily with high speed tools. A large back and side rake to lathe tools is advisable. In some cases very quick softening for machining is accomplished by quenching from temperatures between 1200° and 1600° F. (650 · 875° C.). The fact that both shot-gun and rifle barrels, with their delicate drilling and reaming operations, have been made of Rezistal shows that its machining qualities are fairly good.

ANNEALING FOR COLD FORMING:—Heating to a temperature of 1950–2000° F. (1065–1093° C.) and holding for ten minutes to one-half hour, but not longer, depending upon the thickness, followed by air cooling will make Rezistal very plastic. In some cases quenching from 2000° F. will also give the necessary ductility.

FORGING and DROP FORGING:—Rezistal Steels may be forged or drop forged but the metal does not flow as readily as ordinary steels; its properties at high temperatures show why this is. It is harder and more elastic and in general requires heavier blows to produce the necessary reduction. The heat should be kept at a good yellow (not white) and if the work cannot be finished before the temperature has fallen below, say, 1700° to 1800° F., it should be reheated. A forging range between 2000° and 1750° F. is desirable, but in certain cases a somewhat wider range can be used depending upon the type of steel and the nature or form of the finished part. Finished drop-forgings, such as turbine blades, should be very clean and free from scale.

WELDING:—Rezistal may be soldered, brazed or preferably welded with the oxy-acetylene flame, using a strip or rod of the same material. Parts to be welded should be sand-blasted or pickled and perfectly free from scale. It can be welded to cast iron by the electrical method. It thus lends itself well to many uses in chemical industries because of its autogenous and electric welding qualities which permit of its manufacture into many forms of chemical apparatus.

USES FOR REZISTAL

It would be impossible to list them all in brief space. The imagination can scarcely scope them, they are so numerous; for ordinary household uses, for electrical and chemical equipment, for marine uses, art metal work, physical apparatus and endless other applications. To suggest a few:

AUTOMOBILES

Radiators, Hub-caps, Body-trim, Spark-plugs and Primer-coils. Wind-shield frames, Pump shafts, Lamps.

BANK AND OFFICE

Door Lock Pins for Safes (polish is permanent and metal is resistant to cutting torch), Safety Deposit Box fronts, Paper Knives, Desk Sets, Rules, Ash-trays.

CHEMICAL LABORATORY

Analytical Balance Parts and Weights (require no lacquer), Hot-plates, Scoops and Pans, Fixtures and Apparatus.

DOMESTIC USES

Indestructible, untarnishable Pans, Baking Dishes, Oven-trays, Butter, Ice-cream and Milk Containers; Hotel and Cafeteria Equipment; Name-plates, Mail-boxes, Washing Machines, Flat-iron facings.

FACTORY EQUIPMENT

Valves and Valve parts, Tanks, Pipe for Acid and Alkali, Pump Rods and Parts, Stack Dampers, Pickling Tubs, Racks, Hooks, Bolts.

FINE ARTS

Art Metal Work, Fire Place Tools, Jewelry, Buckles, House-Hardware, Watch Cases, Spoons, Forks (they will never tarnish), Musical Instruments.

HEAT TREATING EQUIPMENT

Furnace Bottoms, Enameling-trays, Annealing and Case-hardening Boxes, Hardening Trays, Pyrometer Tubes.

MARINE USES

Torpedo Parts, Periscope Tubes, Submarine Parts, Propellers, Motor Boat Shafts.

PHYSICAL AND ASTRONOMICAL

Mirrors, Apparatus, Resistance Wire, Electric Heaters, Standards of Length, Burner Caps in Calorimeters, Gauges.

MISCELLANEOUS INDUSTRIES

BRASS:—Rods for stirring and skimming. Die-casting Dies.

TANNERY:—Leather Gauges.

SURGICAL:—Orthopedic Appliances.

GLASS:—Molds and Punches.

REFINERY:—Gasoline, Benzol and Hot Oil Pumps.

CARPENTRY:—Squares and Compasses.

MINING:—Pump Shafts for Mine Water.

REFRIGERATION:—Ice and Liquid Air Machinery; Ice-box Linings and Racks; Food Containers and Kettles.

In short, wherever material is needed that is non-corrosive, acid and alkali resisting, heat-resisting, strong and tough.

The list might be greatly extended, but we prefer to leave the matter of adaptions to the enlightened interest of those who have read these pages with care and discrimination.

ATHA 2600 ALLOY

Where the most extreme cases of corrosion are not involved and exceedingly high temperatures are not encountered, 2600 finds its field. For the most extreme conditions of either corrosion or temperature the other Rezistal Steels are recommended. 2600 may be considered as the "regular" type and the other Rezistal alloys previously described as the "ultra" or "last word" varieties, especially designed to meet specific problems of great difficulty.

It is a non-corrosive, non-magnetic alloy of Nickel, Chromium, Silicon, and Copper with Iron. It is one of the Alloys within the Rezistal patents approximating the following analysis:

Carbon, various under	.50
Manganese	.70
Silicon	1.75
Chromium	8.00
Nickel	22.00
Copper	1.00

Like steel, it is capable of being hot rolled into bars and sheets, cold drawn or cold rolled into wire or strip, forged and cast.

A very important fact to remember is that 2600 is 10% lower in specific gravity then cupro-nickel, which means that it is 10% cheaper at the same price.

It is an austenitic alloy, and its non-corrosive properties are natural and not the result of heat treatment. Its strength can be compared to a high grade forging steel or annealed tool steel with the exception that by proper manipulation it can be furnished with physical strength consistently greater. Being austenitic it is not subject to heat treatment as a means of increasing its physical strength. Any increase in strength and elastic properties of which this alloy is capable, must be produced by means of mechanical work and proper finishing temperatures.

Its usefulness and field of application is very broad, and because of its useful properties described hereafter, it has met a large demand in industry. Price and Classification of Extras furnished on application.

NON-MAGNETIC PROPERTIES

This alloy in its natural condition is non-magnetic to the extent that it will not attract a compass needle. It is not attracted by a permanent horse-shoe magnet. For all commercial purposes it can be safely recommended as non-magnetic.

NON-CORROSIVE PROPERTIES

2600 is completely resistant to a large number of commercial acids, and corrosive agents. It is only slightly affected by others to the extent that it might tarnish and thereafter further action ceases. It is very much more resistant than ordinary steel to such acids as affect it noticeably. It is not a "cure all" for all corrosion problems. Its true value, however, can be represented as a machinable, non-corrosive steel or alloy of superior quality to numerous non-corrosive alloys at present on the market.

This alloy is very resistant to rust, and staining in atmosphere, pure water, oxygen and water, and carbonated water. It is particularly resistant to cold Sulphuric Acid, Butyric Acid, Oleic Acid, Tannic Acid, Lactic Acid, Phosphoric Acid, Formic Acid, Ammonia Water, Sodium Peroxide, Sodium Chloride, Potassium Hydroxide, Hydrogen Peroxide, Hydrogen Sulphide and Steam. In all of these it is either completely resistant to staining or else the loss of weight

for an extended period is so small as to be almost negligible. In hot Sulphuric Acid it shows a progressive loss, small but constant. It can be compared with low Carbon Steel as approximately

300 to 1	5% Hot Sulphuric
500 to 1	10% Hot Sulphuric
1200 to 1	30% Hot Sulphuric

It is superior to cupro-nickel alloys in Ammonia Water, Butyric Acid, Oleic Acid, Sodium Peroxide, and Hydrogen Sulphide and Steam. In others mentioned above it shows approximately equal advantage. It must be mentioned, however, certain cupro-nickel alloys are superior with cold dilute Nitric Acid, but on the other hand concentrated Nitric Acid attacks cupro-nickel very readily whereas 2600 is slightly attacked.

It shows marked superiority to Stainless Iron in use with Sulphuric Acid, Phosphoric Acid, Formic Acid, Lactic Acid, Acetic Acid, Butyric Acid, and Hydrogen Sulphide and Steam.

The non-corrosive qualities mentioned are not affected to any noticeable degree by annealing or heat treatment, with the exception in a number of instances heating to 1600° F., quenching in water shows a slight improvement. A series of tests, heating in normal furnace atmosphere, proved there is no serious oxidation, scaling or pitting until temperatures exceed 1800° F.

MACHINING PROPERTIES

Naturally tough, it is never as readily machinable as steel, but is possible to machine for any ordinary commercial purpose. The machining quality can be varied, more or less; machinability, however, is dependent on requirements for maximum strength. These two must be properly balanced for the character of operation to produce the finished part and to meet the service demands required. Ease of machining is controlled by proper annealing methods and the right design of tool. Annealing by quenching in water from 1200° to 1600° F. produces maximum ease of machining consistent with strength of material. We recommend the use of tools with keener angles than those generally used for steel or cast iron. Where difficulty is encountered, trial with larger Rake, Clearance, and Lip Angles will improve results. For a large number of purposes it has been demonstrated quite easy to machine; it can be turned, milled, shaped and drilled. It may be necessary in some cases to perform these operations at reduced speeds and feeds.

PHYSICAL PROPERTIES

Coefficient of Expansion	.0000189 per 1° C. 20° to 600° C.
Specific Gravity	7.95
Electric Resistivity	525 Ohms per mill. ft.
Temperature Coefficient	.00081 per degree centigrade
Weight per Cubic Inch	.29 Lbs.
Weight per Cubic Foot	500 Lbs.

Maximum strength and elastic properties are dependent to a considerable extent on requirements for machinability. While these properties are limited, due to the nature of the alloy, they can be controlled and varied within a fairly wide range. Since variation in physical strength must be produced as a result of mechanical work, cross section and dimension are an important factor in determining the results.

The approximate physical values are as follows:

For simple machining operations:

Ultimate Strength	105,000 to 125,000 Lbs. per sq. in.
Yield	75,000 to 95,000 Lbs.
Proportional Limit	55,000 to 70,000 Lbs.
Elongation	25% to 35%
Reduction of Area	40% to 55%
Modulus of Elasticity	27,000,000 to 30,000,000

For moderate operations, annealing at 1200° F., and quenched in water, will improve ease of machining with only a slight drop in physical value.

For complex machining with maximum ease, annealing at 1600° F., quenched in water, will produce approximately the following results:

Ultimate Strength	95,000 to 110,000 Lbs.
Yield	55,000 to 65,000 Lbs.
Proportional Limit	35,000 to 50,000 Lbs.
Elongation	25% to 35%
Reduction of Area	40% to 50%
Modulus of Elasticity	27,000,000 to 30,000,000

The higher limits in each case represent the smaller average sizes; the lower limits the larger average sizes.

It is easy to understand that with physical properties as illustrated this alloy not only has value as a non-corrosive metal but in addition will replace in many instances steel parts or castings of lower tensile value.

STRENGTH—HIGH TEMPERATURES: Physical tests performed at high temperatures show:

Up to 500° F. there is almost no change in maximum strength or elastic properties, followed by a gradual drop of about 15% at 1000° F.

It is not until 1000° F. is exceeded that marked change takes effect, but even then the drop is gradual, but at a somewhat increased rate. This can be considered as a remarkable exhibit.

Normal steels, cupro-nickels and other non-corrosive alloys show a gradual decline starting with low temperatures, and usually with a sudden falling off between 400° to 600° F.

2600 can be recommended for a multitude of purposes where in addition to corrosion resistance, retention of maximum strength at high temperatures is required; such as valve trimmings, valve seats, valve parts, particularly for the oil industry and high pressure power plants.

The question may be raised as to abrasion resistance, for parts where at present heat treated steel is being used. Our tests indicate 2600 will resist mechanical abrasion to almost the same degree as normal steels heat treated to approximately 280 to 340 Brinell.

FORGING: 2600 can be drop forged, hot pressed and upset successfully. We recommend starting temperature 1950° to 2100° F., depending upon section and weight. Soak well. Finish not lower than 1600° F. If for extended operations heat falls below 1600° F. we recommend reheating.

Where necessary to machine, forgings should be annealed by any one of the three following practices, depending upon extent of machining.

Heat 1200° F., quench in water.

Heat 1600° F., quench in water or slow cool in furnace.

Heat 1750° F., slow cool in furnace or bury in lime.

CASTINGS: 2600 has been cast successfully, but this field has not been fully developed.

WELDING: This alloy can be welded successfully by the autogenous method. It can also be soldered and brazed.

USES FOR ATHA 2600

Ammonia Pumps
Auto Trimmings
Acid Pumps
Auto Valves
Auto Pump Shafts
Acid Containers
Blower Parts
Beater Blades
Bleaching Machinery
Bolts
Boxes, Safe Deposit
Buckles
Centrifugals
Castings
Cheese Knives
Carburetor Needles
Canning Machinery
Cooking Utensils
Dyeing Machinery
Dental Equipment—except cutting tools
Dairy Machinery
Dehydrators
Drop Forgings
Ejectors
Evaporators
Extractors
Fertilizer Pans
Fans
Felt and Hat Machinery
Forks
Golf Heads
Gas Engine Valves
Gaskets
Gauges
Glue Knives
Hardware
Hospital Equipment
Hotel Equipment
Knives—not requiring a keen edge such as for cake, butter, pie, etc.
Kerosene Stoves
Kitchen Utensils
Laundry Machinery
Marine Trimmings
Mine Pump Parts
Magneto Parts
Meat Cutting Machinery
Measuring Rules
Measuring Instruments
Meters, gas, oil and water
Metal Mirrors
Nuts
Nails
Novelties
Oil Burners
Oil Still Plugs
Pump Rods
Periscope Tubes
Propeller Shafts
Pumps
Printers' Rules
Packers' Machinery
Pipe, Mine Water, Marine, Acid Lines
Plugs, Acid Lines and Tanks
Rails, Furnaces
Restaurant Equipment
Surgical Appliances
Steam Fittings
Stills
Sterilizers
Shafting
Spoons
Toys
Tubing
Turbine Blades
Turbine Beading
Tie Rods
Valve Trimming
Valve Seats
Valves
Washing Machinery
Water Fittings

STAINLESS IRON AND STEEL

It may not be scientifically correct to call a product of 0.10 carbon and 13.0 chromium "Iron,"—it is not iron but steel. Occasionally, usage has a great deal to do with names and designations of things and so by general usage this product is known as Stainless Iron, even though it responds wonderfully well to heat-treatment, and the alloy is made by melting and pouring into ingots and not by the puddling process. The difference between Stainless Iron and Stainless Steel is one of degree and below 0.12 carbon with 9.0 to 16.0 chromium is called "Iron" and above 0.12 carbon "Steel." This division is such that the low carbon product may be said to have no air-hardening properties while at slightly above 0.12 carbon the steel shows air-hardening properties which must be guarded against, particularly in the billet and hot rolled state. Prices and Classification of Extras furnished on application.

STAINLESS IRON

This product is of the greatest importance where high physical properties are needed combined with great resistance to atmospheric and sea-water corrosion, also corrosion by fruit and vegetable acids and even nitric acid. The result of heat treating a sample of 0.10 carbon, 14.37 chromium is as follows:

	Yield Point	Tensile	Elongation	Reduction	Brinell
Hot Rolled	77,650	164,250	11%	28.2%	321
Normalized, 1600° F.	51,100	81,950	26	73.4	192
Annealed, 1380° F.	42,900	73,300	35	73.6	153
Oil-Hardened, 1750° F.	157,250	173,000	12	33.7	340
Oil-Hardened and Dr. 700° F.	131,400	155,100	17	50.9	321
Oil-Hardened and Dr. 1000° F.	131,900	144,650	19	65.3	293

The hot rolled material machined with difficulty; both the normalized and annealed machine easily and smoothly. The heat-treated and drawn samples machine fairly well.

On account of its good physical properties this steel finds a ready market, where strength and anti-corrosion properties are needed.

It makes good turbine blades, either by machining or drop forging and may also be used in sheet form for stationary "cast-in" blades. Chromium toward the upper range and higher, particularly in the presence of copper and silicon, does not show good response to hardening and frequently displays marked brittleness in the Izod test. Normal Stainless Iron, for combined strength and stainlessness is a very valuable addition to our engineering materials. Since it can be forged, pressed and deep-drawn readily it can be used in place of brass, bronze, Monel and nickel-plated ware for many household purposes—name plates, drawer handles, electric fixtures, fireplace tools, also for automobile trim, wind-shield frames, hub-caps, handles, lamps and radiator bodies. The annual bill for polishing such metal parts is enormous. Think what it would mean to use a metal that didn't tarnish!

STAINLESS STEEL

This material usually contains about 0.30 carbon with 9.0 to 16.0 chromium but is at its best with from 12.0 to 14.0 chromium. To develop its best stainless qualities it must be hardened from a temperature sufficiently high to cause virtually a complete solution of the carbides. Once perfectly hardened, it does not lose its stainless qualities by drawing the temper to 900/950° F. The standard tests for stainlessness in this steel are by the use of vinegar and salt, acid copper sulphate solution, and immersion in 1.20 sp. gr. nitric acid, cold.

Because of its stainless qualities coupled with great hardening capacity, this steel finds a great field for table knives, dental tools, surgical instruments, meat cutters, etc. It takes a high polish but requires more care than in polishing carbon tool steel. It requires a good "bottom" before buffing is commenced and it is subject to over-heating or "grinder's scorch" if care is not used. Such spots will not be perfectly stainless. A recent sample sent to one of the large observatories in the form of a six-inch disc for a reflector was ground and polished flat to within 1/10 of a wave length of light or about 1/500,000 of an inch.

If greater strength than Stainless Iron will give is needed, Stainless Steel may be used to advantage as it will develop 225,000 to 250,000 lbs. tensile strength upon hardening at 1800° F., and it retains its strength up to drawing temperatures of 950° F. at which degree of tempering it will show 7 to 9% elongation and 20 to 25% reduction of area. The hardening, tempering, uses and properties of both

Stainless Iron and Steel have been so fully and frequently described that we need not enter into more detail here. They fill a place not filled by Rezistal and vice versa. With such a wide selection of products, there still remains the difficult problem of selecting the right one for any particular use, and it is in this connection that our years of research, experiment and experience will be found of the utmost value to those perplexed over various problems. We have not treated the subject exhaustively in this article, but have merely presented the subject in its broadest terms and have shown what a wonderful series of ferrous alloys are available. We should like to help you solve your individual problems as occasion or opportunity permits.

Stainless Steel is supplied in standard sizes of round, square, flat and double beveled bars, sheets, blocks, discs and rings.

FORGING:—Stainless Steel may be forged at a temperature of from 1800° to 2000° F. but no forging work should be done upon the steel after the temperature falls below 1600° F. If worked below that temperature, cracks are very apt to develop. The parts may be reheated as often as necessary in order to bring them to the proper shape. After forging, the parts should always be allowed to cool slowly from the finishing heat, as this steel has marked air hardening properties. We recommend burying the forgings in charcoal or lime while cooling.

ANNEALING:—Stainless Steel is readily machinable when annealed by heating to 1450° F. and held at that temperature for several hours. The steel should then be permitted to cool slowly in the furnace.

HARDENING:—Hardening is necessary to bring out the stainless qualities of the steel. In the unhardened state it is not stainless. Hardening heats range from 1700° to 1900° F. The stainless quality is developed to the highest degree by hardening from 1800° to 1850° F., preferably in oil. Higher temperatures may be used if extreme hardness is desired, cooling in oil. Care, however, must be used in heating thin sections to avoid distortion. Best results are attained if held at full hardening heat to permit complete solution of the carbides.

TEMPERING:—After hardening, the temper of the steel should be drawn sufficiently to produce the hardness and toughness desired. The use of temper colors for this steel is not possible. Therefore we recommend the use of a bath or furnace held at a suitable temperature.

POLISHING:—Any article made from Stainless Steel will not keep a clean, bright surface unless thoroughly cleaned or polished after hardening and tempering. Scale not removed will rust or stain.

WELDING:—This steel can be electrically welded.

MECHANICAL PROPERTIES:—The properties of Stainless Steel, so far as they bear on its use for machine parts, may be illustrated by the following series of tests:

Drawing Temp.	Elastic Limit	Tensile Strength	Elong. in 2"	Reduction of Area	Shore Scleroscope	Brinell
200°C. (392° F.)	186,500 lbs.	225,000 lbs.	9.0%	25.4%	69-72	418
300°C. (572° F.)	193,500 lbs.	223,500 lbs.	8.6%	27.7%	68-69	418
400°C. (752° F.)	183,500 lbs.	224,000 lbs.	9.6%	29.5%	69-71	418
500°C. (932° F.)	152,000 lbs.	195,000 lbs.	10.0%	28.5%	68	418
600°C. (1112° F.)	122,500 lbs.	144,000 lbs.	14.4%	45.9%	50	269
700°C. (1292° F.)	91,000 lbs.	122,000 lbs.	22.0%	59.1%	42	217

"NON-COR" FERRO-NICKELS

We have manufactured for many years, under the trade name "Non-Cor", a series of high nickel alloys, containing 25% nickel and upward, known as ferro-nickels. These alloys possess many interesting and valuable physical properties, such as high electrical resistance, low magnetic permeability, and more particularly are of interest because of the series of coefficients of expansion which may be obtained from the appropriate mixture. One low expansion alloy, for temperatures not exceeding 100° C., has a coefficient of expansion of approximately 0.000001. The coefficient increases at higher temperatures, particularly above 200° C. Other alloys possess coefficients intermediate between this and the coefficient of ordinary steel. One alloy shows the same coefficient of expansion as platinum and another the same as that of glass. This range of possibilities makes the ferro-nickels of great industrial importance, particularly in the manufacture of thermostatic elements, standards of lengths, measuring tapes, etc. These alloys are moderately resistant to atmospheric corrosion and to the action of certain acids.

Prices and Classification of Extras furnished on application.

COLD MELT ELECTRIC FURNACE ALLOY STEELS

The Crucible Steel Company of America, and its subsidiaries, are the pioneer manufacturers in the United States of Electric Furnace Alloy Steels. Today this Company has fourteen electric furnaces and a capacity of from 75,000 to 100,000 tons per annum. This is the largest electric furnace capacity for cold melting in the United States. In the Crucible Steel Company's plants, steel is handled in a quality way in small units and with all the care that is habitually given to the product of a tool steel mill.

The constantly increasing demand for Electric Furnace Alloy Steels indicates that automotive manufacturers and engineers who are maintaining, or are striving to attain, a reputation for reliability with accompanying popular demand, are realizing that their product demands the best obtainable materials and that they cannot afford to compromise on the quality of the steel for their vital and essential parts.

Our Cold Melt Electric Furnace Alloy Steels represent the highest attainment in steel melting today. The ever-increasing demand from automobile and truck manufacturers of the first rank, is ample proof that our Electric Furnace Alloy Steels are regarded by the trade as the highest standard of excellence.

SPECIAL OPEN HEARTH ALLOY STEELS

We take pride in the quality of the Alloy Steels made in our small basic and acid open hearth furnaces. The greatest care is exercised in the selection of raw materials, and particular attention is paid to the refining process. We keep these furnaces under proper control, which assures us of steel showing a minimum of segregation and impurities.

We furnish our Alloy brands outlined in the following section, as well as all of the standard S. A. E. Analyses for Alloy Steels made in the electric furnace or in open hearth. We have ample equipment for furnishing all of these steels, either hot rolled, rough turned, cold rolled; in the natural condition for forging, in the annealed condition for machining, heat treated and annealed for machining and service without further hardening, or heat treated and annealed for high tensile properties and hardness.

APPLICATION OF TENSILE AND STRESS DIAGRAMS

That steel showing the highest ultimate strength, elastic limit, and stress values, either under tension, compression, shearing or torsion, together with the desired degree of toughness, as measured by the elongation, reduction of area, degree of deflection, or angle of twist, permits of lighter construction through a reduction of section; or if the section be maintained, offers a greater margin of safety. In automobile and aeroplane construction, both of these features are especially desirable, and in many other instances they are absolutely necessary to success. These diagrams become of great value in clearly presenting these features, as the following will illustrate:

Upon referring, for instance, to the tensile test diagrams and the curve marked, "Ultimate Strength", it will be seen from the values in the margin, that the maximum figures are those under the heading "Hardened", on the left, and the minimum figures on the right under "Annealed". Between these extremes, the intermediate ultimate strengths are the result of heating the hardened specimens to intermediate temperatures, that is to say, temperatures gradually increasing from those employed in tempering to those used in annealing, and the values can be quickly ascertained by following the horizontal line from its intersection with the curve to the margin. It will be noted that as the ultimate strength and elastic limit decrease, the elongation and reduction of area increase, and their values corresponding to any ultimate strength are determined by the intersection of the curves with the vertical line. Thus, referring to Duplex Gear Steel No. 1 Tensile Test Diagram, upon following the 250,000 lbs. per square inch horizontal line to the intersection with the curve of ultimate strength, then along the vertical line to where it meets the curves of elastic limit, reduction of area, and elongation, the values of these are read off by following out the horizontal line to the left margin:

Ultimate Strength	250,000 lbs. per square inch.
Elastic Limit	225,000 lbs. per square inch.
Elongation	11.8 per cent.
Reduction	42 per cent.

Having determined through experience or otherwise that 12% elongation and 45% reduction of area represents the minimum degree of toughness permissible, and that steel with the maximum ultimate strength and elastic limit is desired, we turn to our diagrams and find the following:

	Ult. Strength lbs. per sq. in.	Elast. Limit lbs. per sq. in.	Elongation per cent	Reduction of Area per cent
Duplex Gear Steel No. 1.....	235,000	208,000	12.00	45.5
Duplex Gear Steel No. 2.....	192,000	165,000	14.00	45.0
Alva Duplex Forging Steel.....	165,000	150,000	16.25	45.0
3½ per cent Nickel Forging Steel.	200,000	178,000	14.00	45.0
Simplex Forging Steel.....	155,000	135,000	12.00	45.0

Of course, the whole story of adaptability is not told in the tensile test values, inasmuch as hardness, wearing properties, warpage in the heat-treating operation, and other features characteristic of each individual steel, must be considered in selecting steels for any specific purpose.

DUPLEX GEAR STEEL No. 1

This is an oil-hardening Chrome Nickel Gear Steel containing about 3½% Nickel and 1¼% Chromium. After tempering, it is one of the strongest and toughest of the Chrome Nickel Gear Steels made. It is particularly adapted and is used extensively for transmission and differential gears and pinions in high grade automobiles, for aeroplane and submarine parts, and for innumerable purposes where great strength, toughness and endurance are important factors.

It is also used largely for crank shafts, axles and driving shafts, for which purposes it has won great favor because it fulfills the most rigid service demands.

Since it is a steel containing high percentages of alloys, it machines best in the annealed condition. When heat treated and annealed, it will machine readily. In addition it possesses the notable feature of showing less distortion in the final hardening than any other grade of Chrome Nickel Gear Steel.

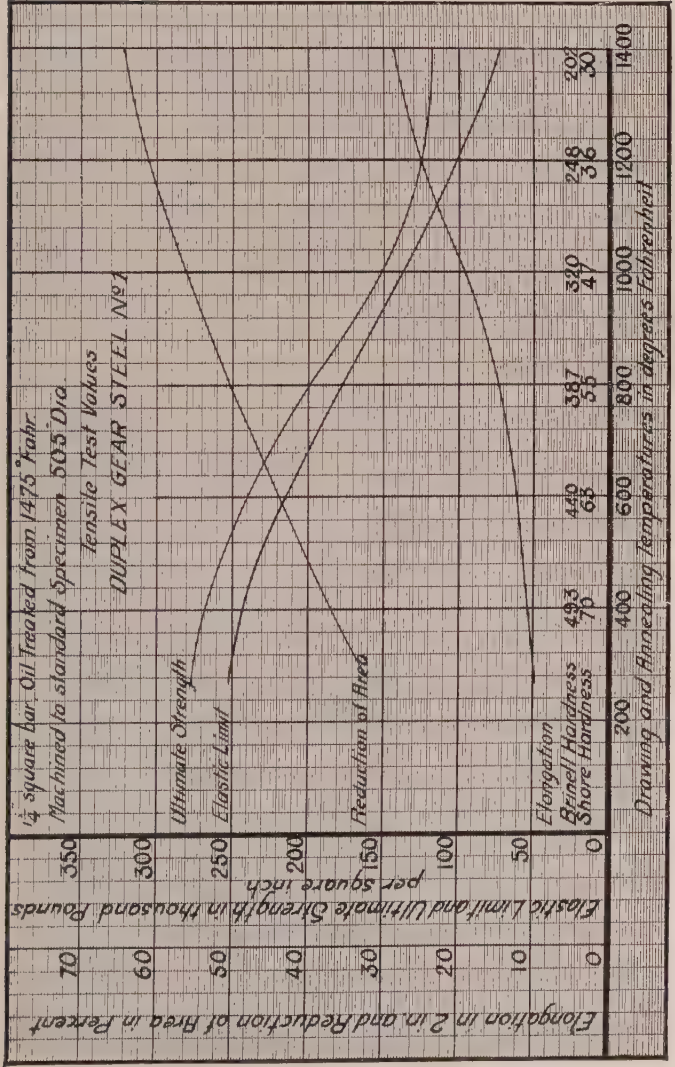
We furnish it in bar form for use in drop forgings, for which purpose it is only necessary to follow simple instructions to handle it successfully. Also in forged discs suitable for gears and pinions, heat treated and annealed to relieve the strains caused by forging and to permit relatively easy machining; and in a great variety of standard sizes and sections.

We guarantee the steel to be in the best physical condition, free from defects, and with all the potential properties of the steel unimpaired, so that the subsequent heat treatment will fully develop all its remarkable inherent qualities. Or we will supply the steel in bars, discs or sections, heat treated to show certain desired physical values.

PHYSICAL CHARACTERISTICS

TENSILE TEST

	Annealed Specimen	Toughened Specimen	Tempered Specimen
Elastic limit, pounds per square inch	65,000	145,000	240,000
Tensile strength, pounds per square inch	95,000	155,000	275,000
Elongation in two inches	29%	19%	11%
Reduction of area	62%	56%	37%
Brinell Hardness Values	156–187	311–364	430–490


1/4 square bar Oil Treated from 1475° Fahr.
Machined to standard Specimen 505 Dia.
Tensile Test Values
DUPLEX GEAR STEEL No 1
Ultimate Strength
Elastic Limit
Reduction of Area
Elongation
Brinell Hardness 493 440 387 320 248 202
Shore Hardness 70 63 55 47 36 30
200 400 600 800 1000 1200 1400
Drawing and Annealing Temperatures in degrees Fahrenheit
Elastic Limit and Ultimate Strength in thousand Pounds per square inch
0 50 100 150 200 250 300 350
Elongation in 2 in. and Reduction of Area in Percent
0 10 20 30 40 50 60 70

DUPLEX CASE-HARDENING STEEL No. 1

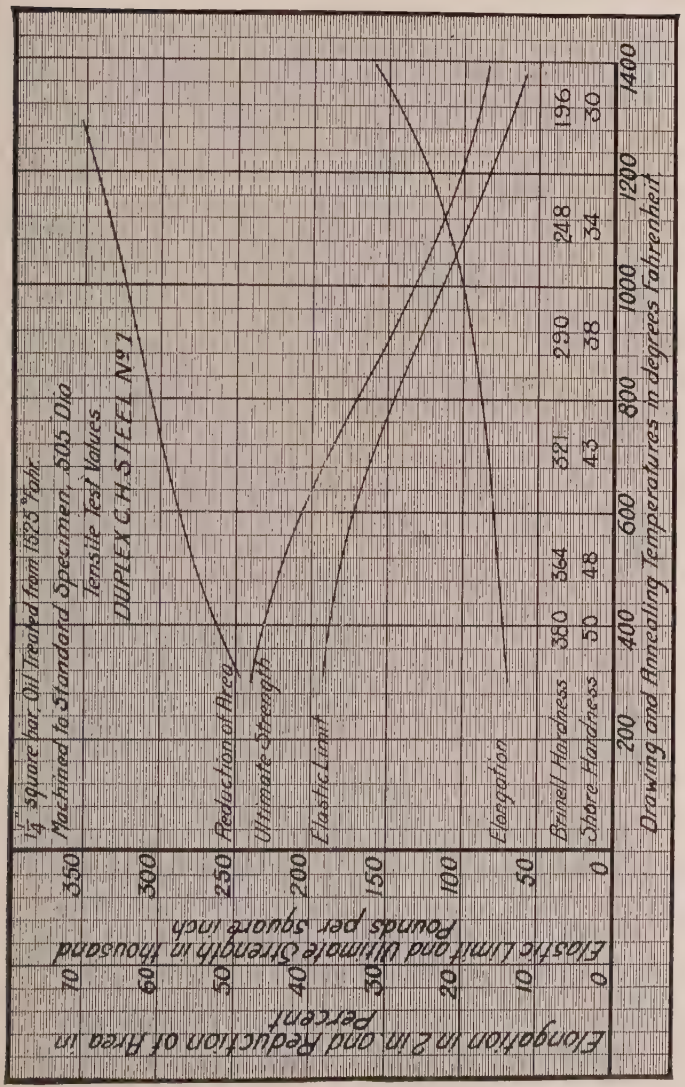
Duplex Case-Hardening Steel No. 1 is a high grade of Case-Hardening Chrome Nickel Gear Steel. It is similar to Duplex Gear Steel No. 1, excepting that it is lower in carbon, to meet the requirements for case-hardening. While it is a steel originally intended for the manufacture of gears, it is adapted to many other uses. It is a steel of unusually high merit, and has been used in the manufacture of cam shafts, clutch pins, crank shafts, connecting rods and all machine parts requiring a case-hardening steel that will successfully resist great shocks and strains.

This brand is supplied in forged discs, suitable for transmission gears and pinions, also in hammered or rolled bars, round, square or flat, and in any other standard section.

PHYSICAL CHARACTERISTICS

TENSILE TEST

	Forging Specimen	Core of Case-hardened Specimen
Elastic limit, pounds per square inch	55,000	170,000
Tensile strength, pounds per square inch	85,000	195,000
Elongation in two inches	24%	15%
Reduction of area	40%	50%
Brinell Hardness Value		321–375


1/4" Square bar, Oil Treated from 1825 °Fahr.
Machined to Standard Specimen, .505 Dia
Tensile Test Values
DUPLEX C.H.S TEEL N° 1
Reduction of Area
Ultimate Strength
Elastic Limit
Elongation
Brinell Hardness 360 364 321 290 248 196
Shore Hardness 50 48 43 38 34 30
200 400 600 800 1000 1200 1400
Drawing and Annealing Temperatures in degrees Fahrenheit
Elongation in 2 in. and Reduction of Area in Percent
0 10 20 30 40 50 60 70
Elastic Limit and Ultimate Strength in Thousand Pounds per Square Inch
0 50 100 150 200 250 300 350

DUPLEX GEAR STEEL No. 2

This is also an oil-hardening Gear Steel, containing about 1½% Nickel and 1% Chromium. It possesses all the desirable attributes of Duplex Gear Steel No. 1, but to a lesser degree except in the matter of hardness in which it excels. This latter feature makes it a very good material for clash gears, especially if they be designed with stub teeth. It was originally intended for automobile gears but its field of use has been greatly extended due to its physical properties. It is a valuable steel for vital parts of machines, such as pinions, counter and crank shafts, axles and transmission parts, subject to extreme shock, wear and stress.

PHYSICAL CHARACTERISTICS

TENSILE TEST

	Annealed Specimen	Toughened Specimen	Tempered Specimen
Elastic limit, pounds per square inch	60,000	120,000	210,000
Tensile strength, pounds per square inch	98,000	140,000	265,000
Elongation in two inches	25%	18%	9%
Reduction of area	58%	55%	28%
Brinell Hardness Values	179–196	280–311	460–512

It does not present great difficulties to the ordinary drop-forger, who, with a moderate degree of care, can handle it most efficiently. After subjecting this steel to a toughening process, it may be used for shafts, crank shafts, axles, etc. It is not, however, as strong and tough as Duplex Gear Steel No. 1, nor does it machine with quite the same degree of ease. Nevertheless it is a most desirable steel.

We furnish Duplex Gear Steel No. 2 in the standard sizes and sections, rolled or hammered, and also in forged discs for gears and pinions, annealed so that the machining may be relatively easy.

1/4 square bar, oil treated from 1500° Fahr.
Machined to standard specimen - .505 Dia.
Tensile Test Values
DUPLEX GEAR STEEL No. 2
Ultimate Strength
Elastic Limit
Reduction of Area
Elongation
Brinell Hardness
Shore Hardness
510 480 420 350 280 212
76 72 64 53 38 30
200 400 600 800 1000 1200 1400
Drawing and Annealing Temperatures in degrees Fahrenheit.
Elongation in 2 in. and Reduction of Area in Percent.
Elastic Limit and Ultimate Strength in Thousand pounds per square inch.
0 10 20 30 40 50 60 70
0 50 100 150 200 250 300 350

DUPLEX CASE-HARDENING STEEL No. 2

Duplex Case-Hardening Steel No. 2 is similar in composition to Duplex Gear Steel No. 2, but its carbon content is adapted to case-hardening. It is made from the very best of raw materials, like all our Duplex Steels, and by methods which insure uniformity of composition and soundness. This steel forges and machines readily and only requires ordinary care to handle it successfully. Its strength and toughness have won unstinted approval from a host of users.

This brand is very much like $3\frac{1}{2}\%$ nickel steel in its machining and forging properties. However, it excels the latter in that the core and case are stronger and tougher. It exhibits the same tensile properties in whatever plane the test specimen is located, which indicates the thorough homogeneity of this product. We strongly recommend it for light gears and pinions in automobiles, aeroplanes, motor-cycles, power-boats and any other mechanism requiring light, but strong and tough gearing.

It is applicable to the manufacture of any of the parts referred to when we were discussing Duplex C. H. Steel No. 1.

PHYSICAL CHARACTERISTICS

TENSILE TEST

	Core of Case-hardened Specimen
Elastic limit, pounds per square inch	140,000
Tensile strength, pounds per square inch	165,000
Elongation in two inches	12%
Reduction of area	50%
Brinell Hardness Value	260–302

1¼ square bar oil treated from 1575°Fahr.
Machined to standard specimen, .505 Dia.
Tensile Test Values
DUPLEX C.H.STEEL N° 2
Reduction of Area
Ultimate Strength
Elastic Limit
Elongation
Brinell Hardness
Shore Hardness
310 44
285 41
260 36
212 30
Elongation in 2 in. and Reduction of Area in Percent
Elastic Limit and Ultimate Strength in thousand pounds per square inch
Drawing and Annealing Temperatures in degrees Fahrenheit
0
10
20
30
40
50
60
70
0
50
100
150
200
250
300
350
200
400
600
800
1000
1200
1400

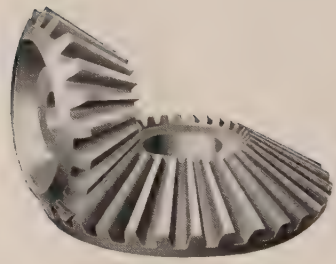
DUPLEX GEAR STEEL No. 3

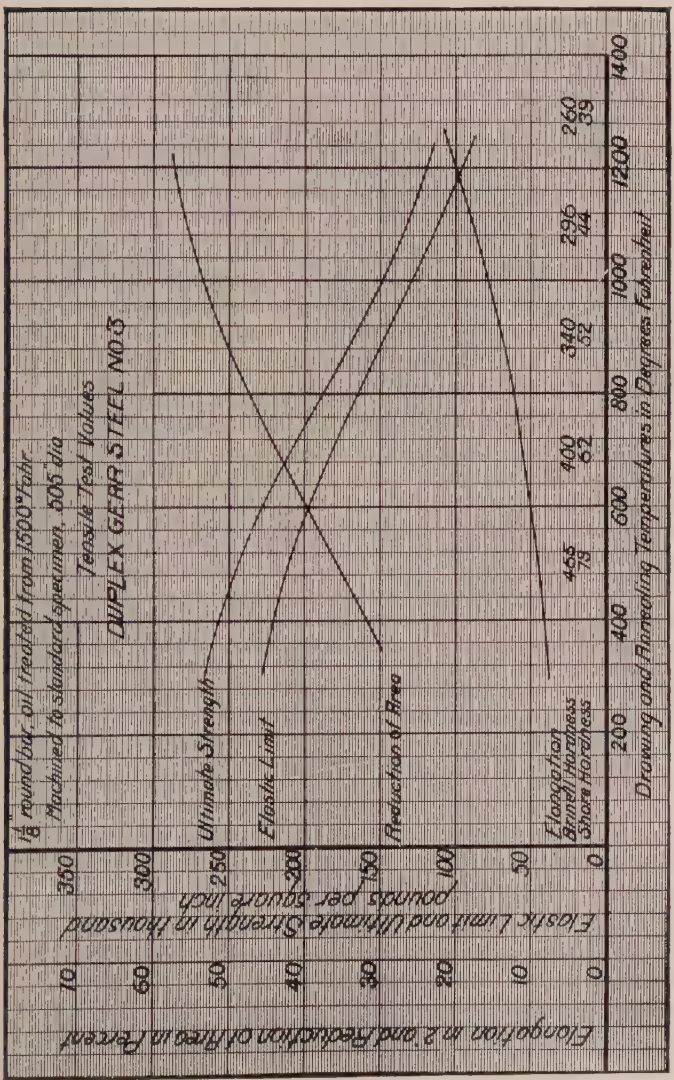
This type of Chrome Nickel Steel contains about 3% Nickel and about 0.75% Chromium. It is a very useful steel for the manufacture of those parts which have been enumerated under the foregoing brands, and is made in both tempering and case-hardening grades.

PHYSICAL CHARACTERISTICS

TENSILE TEST

	Annealed Specimen	Toughened Specimen
Elastic limit, pounds per square inch	60,000	110,000
Tensile strength, pounds per square inch	100,000	135,000
Elongation in two inches	25%	18%
Reduction of area	59%	56%
Brinell Hardness Value		280–311




1 1/8" round bar, oil treated from 1500° Fahr.
Machined to standard specimen, .505" dia
Tensile Test Values
DUPLEX GEAR STEEL NO 3
Ultimate Strength
Elastic Limit
Reduction of Area
Elongation
Brinell Hardness
Shore Hardness
455 79
400 62
340 52
296 44
260 39
Elongation in 2" and Reduction of Area in Percent
Elastic Limit and Ultimate Strength in Thousand Pounds per Square Inch
Drawing and Annealing Temperatures in Degrees Fahrenheit
0 10 20 30 40 50 60
0 50 100 150 200 250 300 350
200 400 600 800 1000 1200 1400

DUPLEX CASE-HARDENING STEEL No. 3

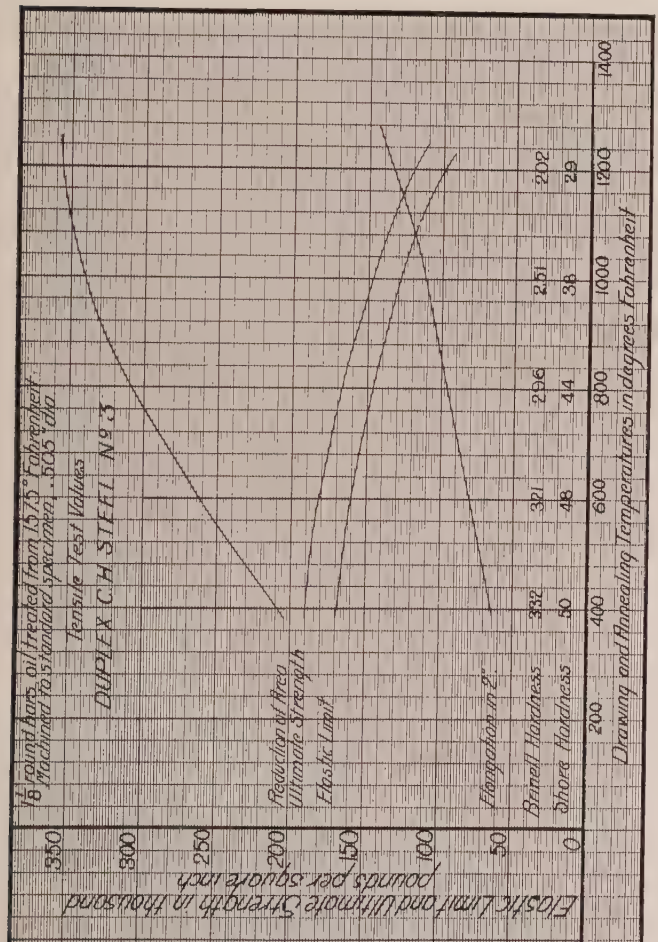
This is a brand of the same composition as our Duplex Gear Steel No. 3, except that the carbon content is lower to permit of successful case-hardening.

The following chart clearly sets forth the physical values of this steel and indicates its possibilities.

PHYSICAL CHARACTERISTICS

TENSILE TEST

	Core of Case-hardened Specimen
Elastic limit, pounds per square inch	155,000
Tensile strength, pounds per square inch	170,000
Elongation in two inches	14%
Reduction of area	48%
Brinell Hardness Value	296–311


1/2" round bars, oil treated from 1575° Fahrenheit
Machined to standard specimens. .505" dia.
Tensile Test Values
DUPLEX CHROME STEEL No. 3
Reduction of Area
Ultimate Strength
Elastic Limit
Elongation in 2"
Brinell Hardness
Shore Hardness
Elongation in 2" and Reduction of Area in Percent
Elastic Limit and Ultimate Strength in thousand pounds per square inch
Drawing and Annealing Temperatures in degrees Fahrenheit
10 60 50 40 30 20 10 0
350 300 250 200 150 100 50 0
332 321 296 251 202
50 48 44 38 29
200 400 600 800 1000 1200 1400

ALVA DUPLEX FORGING STEEL

This brand represents the highest grade of the Chrome-Vanadium Steels, and is the result of a thorough and complete study of the part played by these two elements in combination with each other. The steel machines and forges well. It is adapted to such parts as axles, shafts, crank shafts, bolts, pins and piston rods in automobiles, motors, and power plants of great horse-power, where lightness and strength are of first importance.

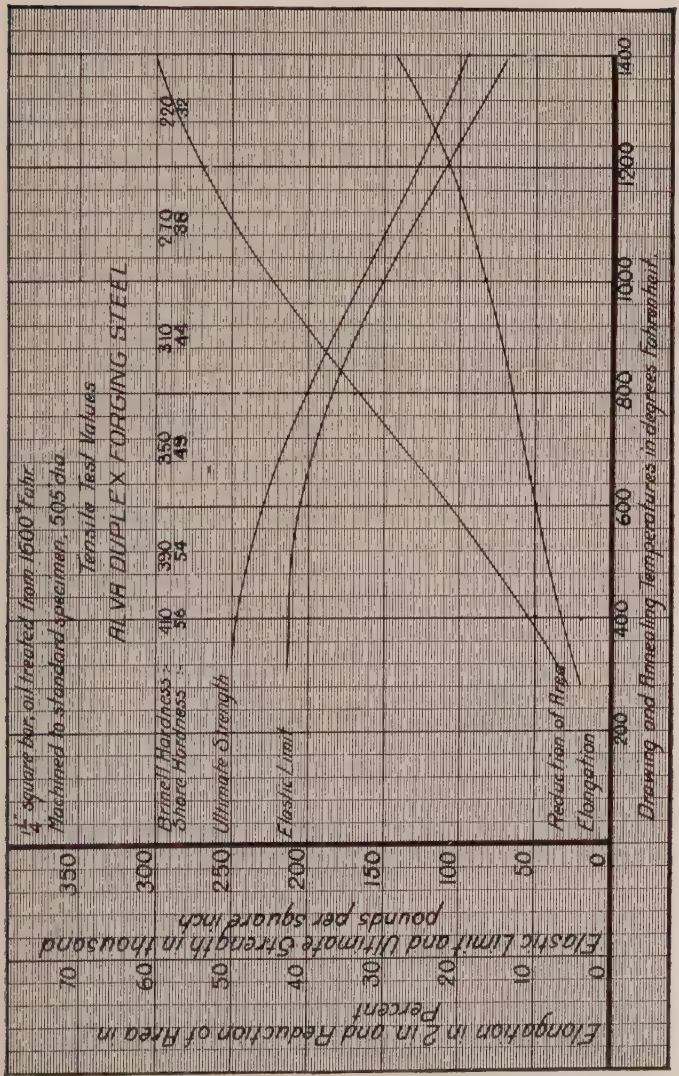
It is used for the making of wrist pins, shafts, axles, studs, bolts, rockers, pistons, and practically every part subjected to great strain or wear, in locomotives, motors, and in general machine construction, also for pins and bolts in hydraulic presses, in marine engines, in high-powered guns, for valves in gas engines, and for rods in steam hammers.

PHYSICAL CHARACTERISTICS

TENSILE TEST

	Forging Specimen	Treated Forging
Elastic limit, pounds per square inch	51,000	112,000
Tensile strength, pounds per square inch	75,000	130,000
Elongation in two inches	25%	20%
Reduction of area	45%	52%
Brinell Hardness Values	179–196	270–292

Standard sizes of Alva Duplex Forging Steel are carried in stock, heat-treated to possess high tensile test values. In this condition, it can be machined, and is then ready for service. When fully annealed, it machines quite readily, but it should be properly heat-treated to develop the required physical properties.


1¼" square bar, oil treated from 1600° Fahr.
Machined to standard specimen, .505 dia.
Tensile Test Values
ALVA DUPLEX FORGING STEEL
Brinell Hardness :-
Sheare Hardness :-
410 390 350 310 270 220
56 54 49 44 38 32
Ultimate Strength
Elastic Limit
Reduction of Area
Elongation
Elongation in 2 in. and Reduction of Area in Percent
Elastic Limit and Ultimate Strength in thousand pounds per square inch
0 10 20 30 40 50 60 70
0 50 100 150 200 250 300 350
200 400 600 800 1000 1200 1400
Drawing and Annealing Temperatures in degrees Fahrenheit.

ALVA DUPLEX CASE-HARDENING STEEL

This grade is similar in composition to Alva Duplex Forging Steel, but being a case-hardening steel, its carbon content is lower. A strong, tough part with a hard, wear-resisting case can be obtained, insuring an unusually long life. Cam shafts, pawls, feed rollers and worms made from this grade have won splendid testimonials to the steel's worth.

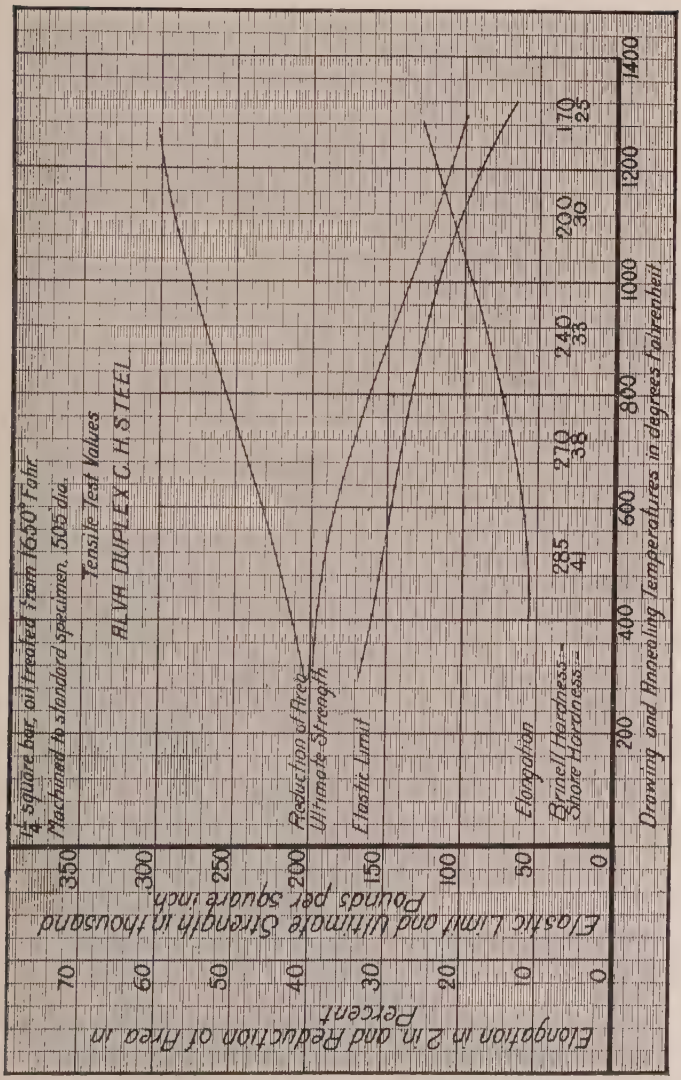
We can furnish Alva Duplex Case-Hardening Steel in any of the standard sizes or sections, and in many special shapes, rolled, hammered or cold-drawn.

PHYSICAL CHARACTERISTICS

TENSILE TEST

	Forging Specimen	Core of Case-hardened Specimen
Elastic limit, pounds per square inch	45,000	135,000
Tensile strength, pounds per square inch	73,000	155,000
Elongation in two inches	30%	12%
Reduction of area	65%	50%
Brinell Hardness Values	163–196	240–270

The accompanying diagram shows additional possibilities of Alva Duplex Case-Hardening Steel.


1/4 square bar, oil treated from 1650° Fahr.
Machined to standard specimen, .505 dia.
Tensile Test Values
ALVA DUPLEX C. H. STEEL
Reduction of Area
Ultimate Strength
Elastic Limit
Elongation
Brinell Hardness
Shore Hardness
285 41
270 38
240 38
200 30
170 25
Elongation in 2 in. and Reduction of Area in Percent
Elastic Limit and Ultimate Strength in Thousand Pounds per Square Inch
Drawing and Annealing Temperatures in degrees Fahrenheit

STANDARD 3½ PER CENT NICKEL FORGING STEEL

This brand is much used for axles, shafts, steering knuckles, etc., in automobiles and in the construction of engine parts. The close attention paid to every detail of manufacture assures the purchaser a steel much above the average of the usual 3½% Nickel Steel.

PHYSICAL CHARACTERISTICS

TENSILE TEST

	Forging Specimen	Treated Specimen
Elastic limit, pounds per square inch	63,000	98,000
Tensile strength, pounds per square inch	103,250	120,000
Elongation in two inches	17%	21%
Reduction of area	35%	57%
Brinell Hardness Values	166	223–293

Machined parts made from our uniform 3½% Nickel Steel are exceedingly tough and strong when heat treated, as the values derived from the diagram will show. We can supply this steel in treated and machinable bars to show any elastic limit up to 100,000 pounds per square inch.

1¼ square bar, oil treated from 1550° Fahr.
Machined to standard specimen, .505 dia.
Tensile Test Values
3½ PERCENT NICKEL FORGING STEEL
Ultimate Strength
Elastic Limit
Reduction of Area
Elongation
Brinell Hardness
Shore Hardness
430 320 310 302 223
40 58 52 46 37
186
30
Elongation in 2 in. and Reduction of Area in Percent
Elastic Limit and Ultimate Strength in thousand pounds per square inch
Drawing and Annealing Temperatures in degrees Fahrenheit
0 10 20 30 40 50 60 70
0 50 100 150 200 250 300 350
200 400 600 800 1000 1200 1400

STANDARD 3½ PER CENT NICKEL CASE-HARDENING STEEL

This steel, containing approximately 3½% Nickel, follows the standard in general use, but it is taken out of the "ordinary" class because of the care it receives in manufacture. It is low in carbon to permit of case-hardening. It machines easily and is well adapted to engine, motor and machine parts, both large and small. When case-hardened, it offers a hard wearing-surface with a tough core, and after a toughening treatment is able to withstand vibration, shock and alternate stresses.

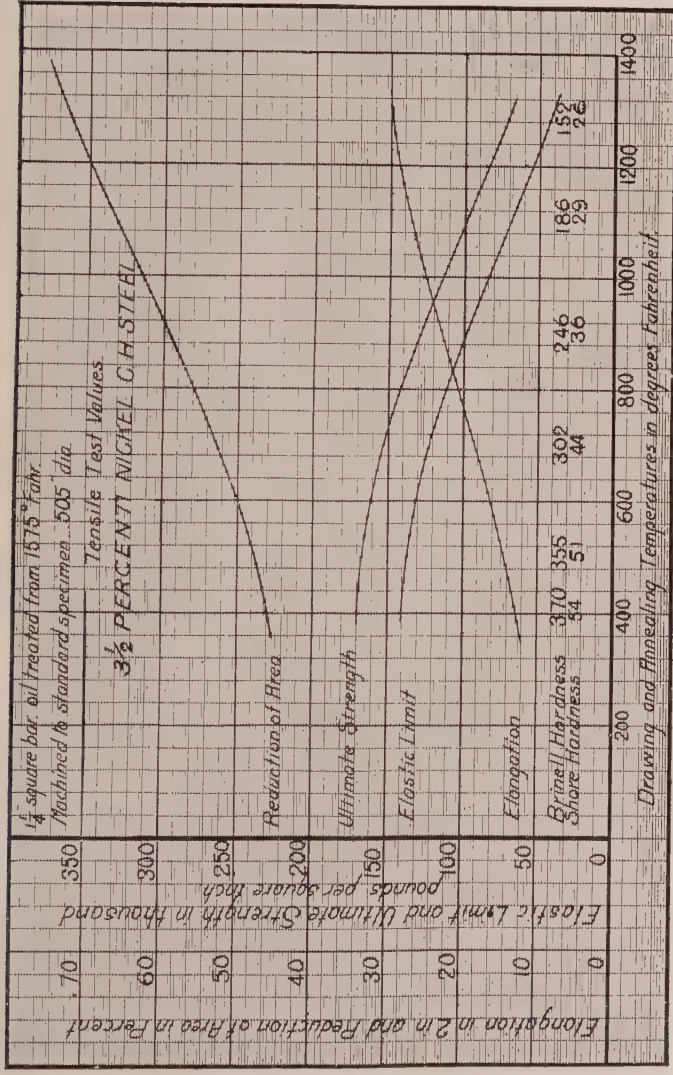
PHYSICAL CHARACTERISTICS

TENSILE TEST

	Forging Specimen	Toughened Specimen	Core of Case-hardened Specimen
Elastic limit, pounds per square inch	42,000	55,000	95,000
Tensile strength, pounds per square inch	68,000	80,000	110,000
Elongation in two inches	23%	25%	18%
Reduction of area	43%	60%	60%
Brinell Hardness Values	162	262	196–262

FIVE PER CENT NICKEL CASE-HARDENING STEEL

Five per cent Nickel Case-hardening Steel is recognized as the highest grade of straight nickel case-hardening steels. It is guaranteed to meet the most rigid inspection and can be treated to very high physical properties for use in gears, crank shafts, turbine blades and other parts where high stresses are required. Because of its low hardening temperature, it is of special interest where freedom from distortion in hardening is of importance as in large ring gears, internal gears, cam shafts, etc.


1¼ square bar oil treated from 1575° Fahr.
Machined to Standard specimen .505 dia.
Tensile Test Values
3½ PERCENT NICKEL C.H. STEEL
Reduction of Area
Ultimate Strength
Elastic Limit
Elongation
Brinell Hardness
Shore Hardness
370 355 302 246 186 152
54 51 44 36 29 22
Elongation in 2 in. and Reduction of Area in Percent
Elastic Limit and Ultimate Strength in Thousand pounds per square inch
0 10 20 30 40 50 60 70
0 50 100 150 200 250 300 350
200 400 600 800 1000 1200 1400
Drawing and Annealing Temperatures in degrees Fahrenheit

SIMPLEX FORGING STEEL

This is an ideal steel containing about 1¼% Nickel and .60 Chromium for the manufacture of all parts which are drop-forged and afterwards treated to develop in them a degree of strength such as would be obtained from a similar carbon temper in 3½% nickel steel. It is the equal in physical properties of 3½% nickel steel without possessing the objectionable tendency to laminate, which characterizes the latter. In other words, it is more homogeneous in texture throughout. The superior forging and machining properties commend this brand to all automobile manufacturers where price is a large factor.

PHYSICAL CHARACTERISTICS

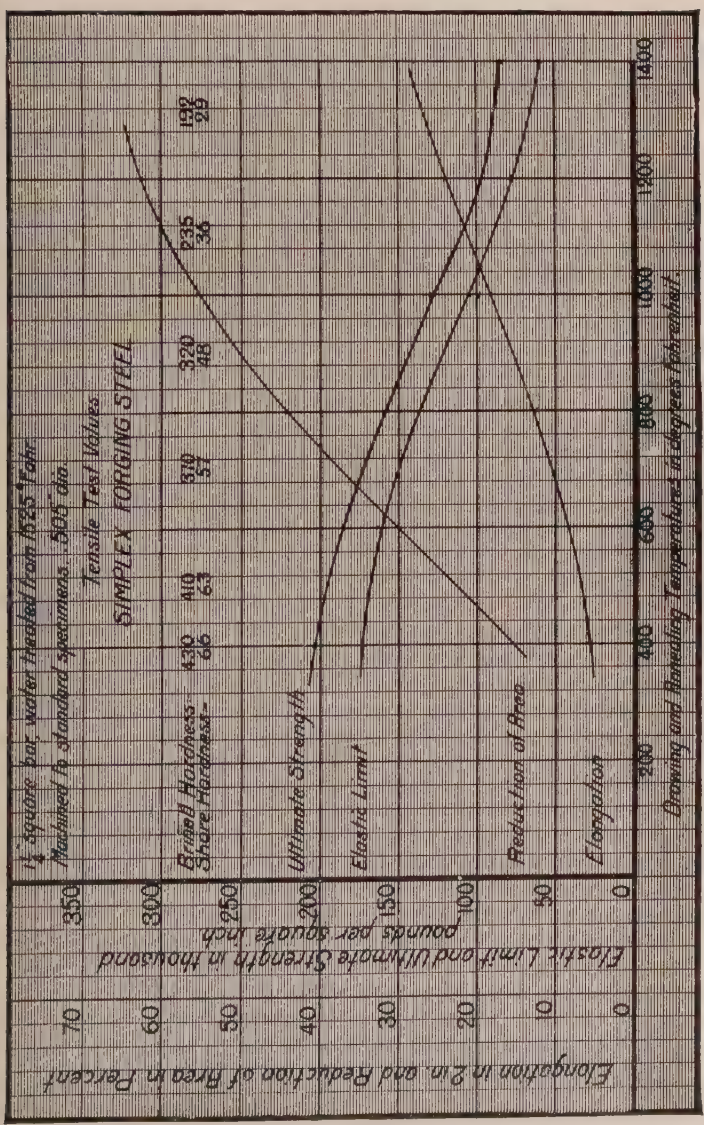
TENSILE TEST

	Forging Specimen	Treated Specimen
Elastic limit, pounds per square inch	50,000	111,000
Tensile strength, pounds per square inch	75,000	130,000
Elongation in two inches	24%	17%
Reduction of area	40%	45%
Brinell Hardness Values	183–202	212–293

Furthermore, it has become a standard steel among the manufacturers of motors, not only in this but also in other countries. It is extensively used for spindles on high-powered lathes, for shafts in marine work, for many parts of long range guns, and for paper mill and jordan bars.

Simplex Forging Steel is carried in stock in round bars, heat treated and annealed. We can supply it rolled, hammered and cold drawn, in many sizes and sections, as specified.

This grade has met with great success when used for high tension bolts for high pressure steam lines and is being used widely for axle shafts, heat treated and annealed for service without further hardening.


1¼ square bar, water Hardened from 1525° Fahr.
Machined to standard specimens .505" dia.
Tensile Test Values
SIMPLEX FORGING STEEL
Brinell Hardness
Shore Hardness
430
66
410
63
370
57
320
48
235
36
192
29
Ultimate Strength
Elastic Limit
Reduction of Area
Elongation
Drawing and Annealing Temperatures in degrees Fahrenheit
200
400
600
800
1000
1200
1400
Elongation in 2 in. and Reduction of Area in Percent
Elastic Limit and Ultimate Strength in thousand pounds per square inch
0
10
20
30
40
50
60
70
0
50
100
150
200
250
300
350

SIMPLEX CASE-HARDENING STEEL

This is a Chrome Nickel Steel, which forges and machines easily, carbonizes readily with a very uniform case, producing a hard wearing-surface and a strong core when properly treated. Being so uniform in composition and so exceedingly homogeneous, it makes good case-hardened gears, pins, bolts, and any of those parts of small section which require hard wearing-surfaces and toughness.

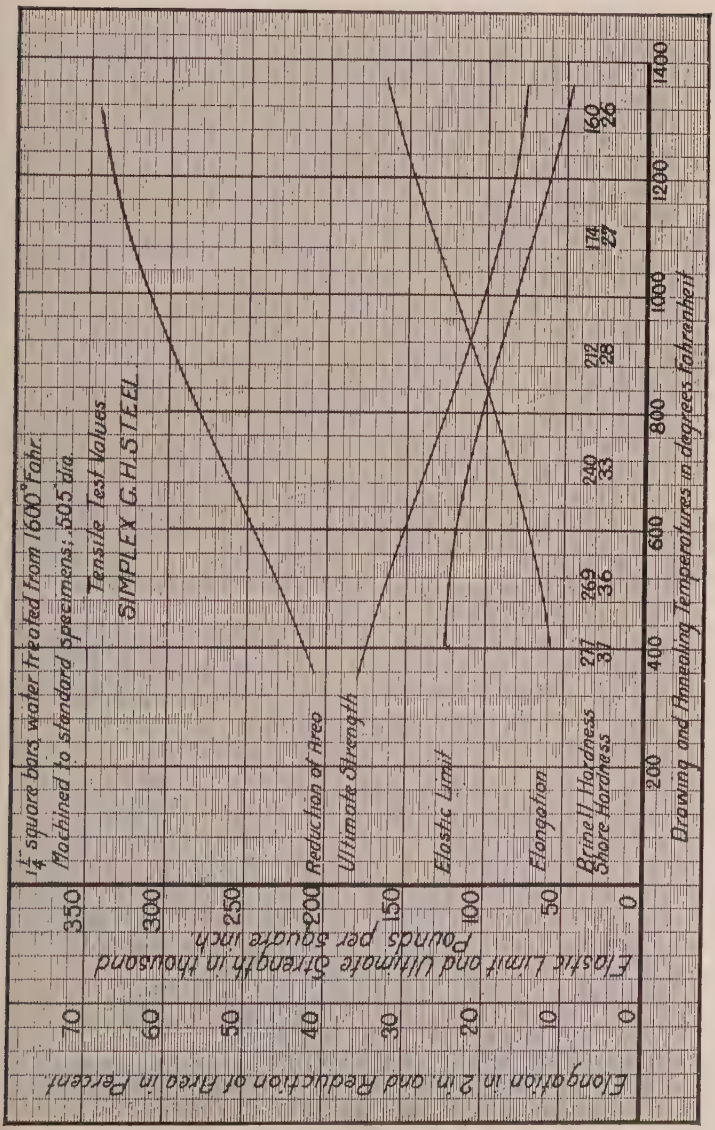
PHYSICAL CHARACTERISTICS

TENSILE TEST

	Forging Specimen	Core of Case-hardened Specimen
Elastic limit, pounds per square inch	40,000	80,000
Tensile strength, pounds per square inch	70,000	90,000
Elongation in two inches	23%	16%
Reduction of area	48%	45%
Brinell Hardness Values	163–183	221–267

The values shown by the diagrams, expressing the possibilities of our Simplex Steels, show them to be wonderful material and, from the price point of view, they are extraordinary.

In composition, our Simplex Steels are the most uniform and dependable of any to be found at similar prices.


1¼" square bars water treated from 1600° Fahr.
Machined to standard specimens; .505" dia.
Tensile Test Values
SIMPLEX C.H. STEEL
Reduction of Area
Ultimate Strength
Elastic Limit
Elongation
Brinell Hardness
Shore Hardness
217
37
269
36
240
33
212
28
174
27
160
26
200
400
600
800
1000
1200
1400
Drawing and Annealing Temperatures in degrees Fahrenheit
Elastic Limit and Ultimate Strength in thousand Pounds per square inch
0
50
100
150
200
250
300
350
Elongation in 2 in. and Reduction of Area in Percent
0
10
20
30
40
50
60
70

A WORD AS TO BALL AND BALL RACE STEEL

The mechanical construction of ball or roller bearings is such that there is a more or less slippage of the balls or rollers and, under load, as in service, this results in the bearing surface gradually sluffing off and ultimate destruction of the bearing. To produce a bearing with the longest life, the qualities most necessary in the steel are resiliency and hardness. The former increases as the elastic limit and toughness values of the steel become greater, and it is this feature to which the greatest attention must be given to eliminate the most potent and frequent cause of ball and roller bearing troubles. Hardness reduces the friction and offers resistance to abrasion. We have, therefore, developed all our ball race, ball and roller steels with the view to combining these qualities to the maximum degree in the hardened parts.

Notwithstanding the difficulty of eliminating slag and oxide inclusions and occluded gases, also surface defects, due largely to the nature of the alloying elements used in the manufacture, our steels are notably free from such defects by reason of the methods we follow. The manufacturing process through all the stages is conducted with the utmost care and the most painstaking inspection with a full appreciation of what is required of the steel under service conditions.

To illustrate the superiority of the Alloy Steel with its greater resiliency, we call your attention to the following table:

ELASTIC LIMIT UNDER COMPRESSION

Dimensions of specimens tested ½" diameter x 1½" length	Shore Scleroscope Hardness
Alloy Ball Race Steels, 419,000 to 364,000 lbs. per square inch	85
Carbon Tool Steels, 243,000 to 220,000 lbs. per square inch	85

CHROME BEARING AND BALL STEELS

As a practical result of our investigations, we have produced the above brands, the highest grades of their kind embodying the special qualities so necessary to Bearing and Ball Steels. When annealed, in which condition we furnish them, the steels machine readily, and when hardened, they combine hardness, strength and resiliency to the maximum degree.

Another especially fine feature is that these grades are not sensitive steels, as they possess quite a range of temperature in which they may be successfully hardened.

For the best and most enduring balls, races, cups, cones and kindred parts, we strongly recommend our Chrome Bearing and Ball Steels, with the assurance that their use will result in the highest efficiency.

SHORE SCLEROSCOPE HARDNESS VALUE

Hardened Specimen	85–90

ALMO STEELS

These Chrome Molybdenum Steels were perfected by us during the war and since that time Chrome Molybdenum Steels have received a great deal of attention and their use has increased rapidly. Molybdenum is not a new element in steel production. We have used it commercially for over twenty-five years. The chief factor in retarding its greater use until recently had been the fear of not being able to obtain a dependable supply of the metal. Notwithstanding the wonderful mineral resources of this country, as regards the base metals—iron, copper, lead and zinc, and of the precious metals—gold and silver, we are almost entirely dependent upon foreign sources for those metals of intermediate character principally used for alloying with steel. These include manganese, nickel, tungsten, chromium and vanadium. None of these metals are found in sufficient quantities in this country to supply our needs. This fact was brought to the attention of the Government very forcibly during the war activities and led to intensive efforts to locate additional sources of supply, not only of these metals but also of molybdenum. The result of these investigations showed that molybdenum existed abundantly in this country and several large deposits have been developed so that the future supply of molybdenum may be considered insured.

The exacting demands for material of particularly high character for aeroplane, motor car and ordnance uses led us to investigate the merits of molybdenum in structural engineering steels, with the result that we developed the Almo Steels, and in our investigations we naturally set a high standard with which to compare the new products. The Almo Steels are characterized by their great toughness without the sacrifice of strength. Toughness is indicated in tensile tests by the reduction of area and in this respect the Almo Steels for equal strength show a greater reduction of area than any other types of alloy steels. These steels are characterized by a wide hardening range and a wide range within which to draw the temper. These characteristics make the steels extremely simple in their heat treatment, particularly for those who have not the most up-to-date equipment.

The three grades known as Almo—Nos. 1, 2 and 3—differ in respect to the richness of the alloy content, No. 1 representing the highest grade. All three grades are produced in a forging, gear and

spring temper, the difference in these three tempers being in the matter of carbon content suitable to the three purposes mentioned.

For case-hardening purposes, a Nickel Molybdenum Steel is preferred to Chrome Molybdenum, as the result of experience in heat treatment. The Nickel Molybdenum Case-Hardening Steels are produced in several grades to meet individual specifications, and in general are lower in carbon and molybdenum than the forging, gear and spring alloys represented by our Almo brands. The nickel content also may vary somewhat in accordance with the individual requirements of different users.

In addition to both Chrome Molybdenum and Nickel Molybdenum, we also produce for special purposes Chrome Nickel Molybdenum Steels which are characterized by very great depth of hardening and extreme toughness in any degree of hardness. Both the Nickel Molybdenum and the Chrome Nickel Molybdenum Steels have been largely used for gun shields, light armor plates and tank plates, their combined toughness and hardness rendering them particularly resistant to penetrating action of bullet fire.

On the following pages are described the characteristics of the Almo Steels, together with charts showing their physical properties as affected by heat treatment.

ALMO No. 1 FORGING STEEL

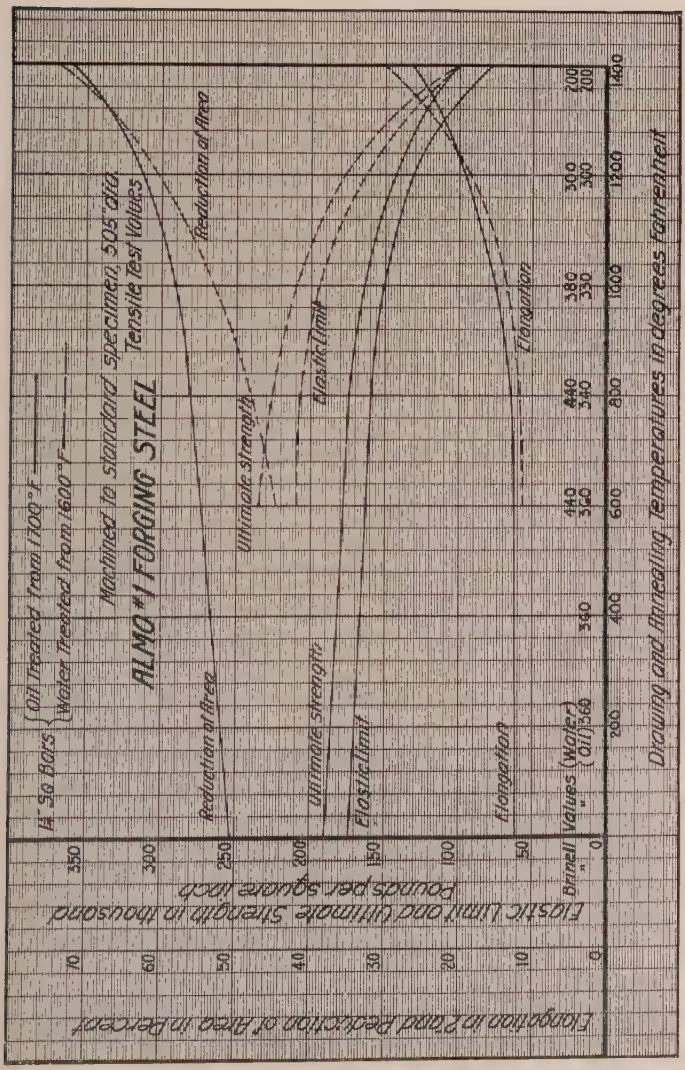
This steel can be made to show the maximum combination of strength and toughness, and we strongly recommend it for aeroplane, passenger car, truck and tractor parts where lightness is a prime factor, and, therefore, material of the highest possible physical properties must be used. For crank shafts, axles, connecting rods, etc., it will be found very superior. Its physical properties are very conservatively given below:

PHYSICAL CHARACTERISTICS

TENSILE TEST

Annealed Specimen		Treated Specimen
88,600	Elastic limit, pounds per square inch	141,500
110,600	Ultimate strength, pounds per square inch	167,300
26	Elongation in two inches	17.5
71.2	Reduction of area	58.7
187	Brinell	340

Almo No. 1 Forging Steel offers no difficulties in the forge shop when handled with a reasonable amount of care, and its machining properties are such that in comparison with the other alloy steels of the same tensile test values it will be found to machine much more readily. Correspondingly higher values are shown by the gear and spring tempers.


14" Sq Bars
Oil Treated from 1700° F
Water Treated from 1600° F
Machined to standard specimen, 505" dia.
ALMO #1 FORGING STEEL
Tensile Test Values
Reduction of Area
Ultimate Strength
Elastic Limit
Elongation
Brinell Values (Water)
" (Oil)
Drawing and Annealing Temperatures in degrees Fahrenheit
Elastic Limit and Ultimate Strength in thousand Pounds per square inch
Elongation in 2" and Reduction of Area in Percent

ALMO No. 2 FORGING STEEL

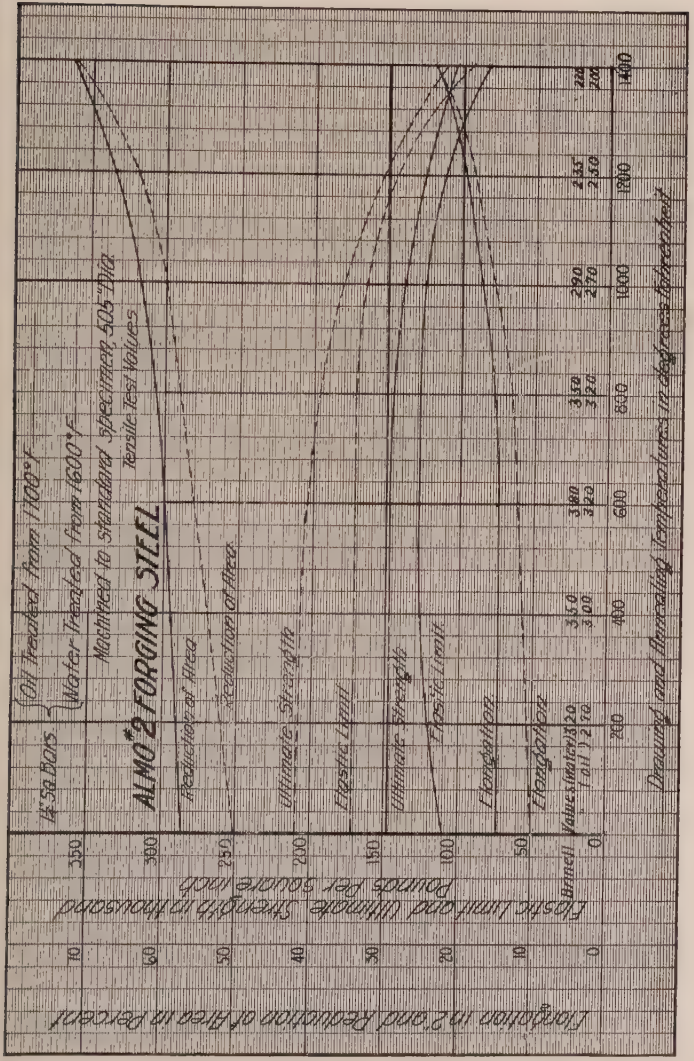
This brand is similar in general characteristics to Almo No. 1 Forging Steel, differing from it only slightly in the tensile and other physical test values obtainable. This steel will have an extensive use not only because of its high quality, but also its reasonable price.

PHYSICAL CHARACTERISTICS

TENSILE TEST

Annealed Specimen		Toughened Specimen
84,700	Elastic limit, pounds per square inch	130,300
105,000	Ultimate strength, pounds per square inch	138,800
24	Elongation in two inches	17
71.6	Reduction of area	62.6
174	Brinell	269

The easy forging and machining properties of this steel will appeal strongly to those who wish to combine ease of manufacture with high physical properties.


ALMO #2 FORGING STEEL
Machined to standard specimen, 505" Dia.
Tensile Test Values
Oil Treated from 1700°F
Water Treated from 1600°F
Reduction of Area
Reduction of Area
Ultimate Strength
Elastic Limit
Ultimate Strength
Elastic Limit
Elongation
Elongation
Brinell Values (Water) 320 350 380 350 290 235 220
(Oil) 270 300 320 320 270 250 200
Drawing and Annealing Temperatures in degrees Fahrenheit
Elastic Limit and Ultimate Strength in thousand Pounds Per Square Inch
Elongation in 2" and Reduction of Area in Percent

ALMO No. 3 FORGING STEEL

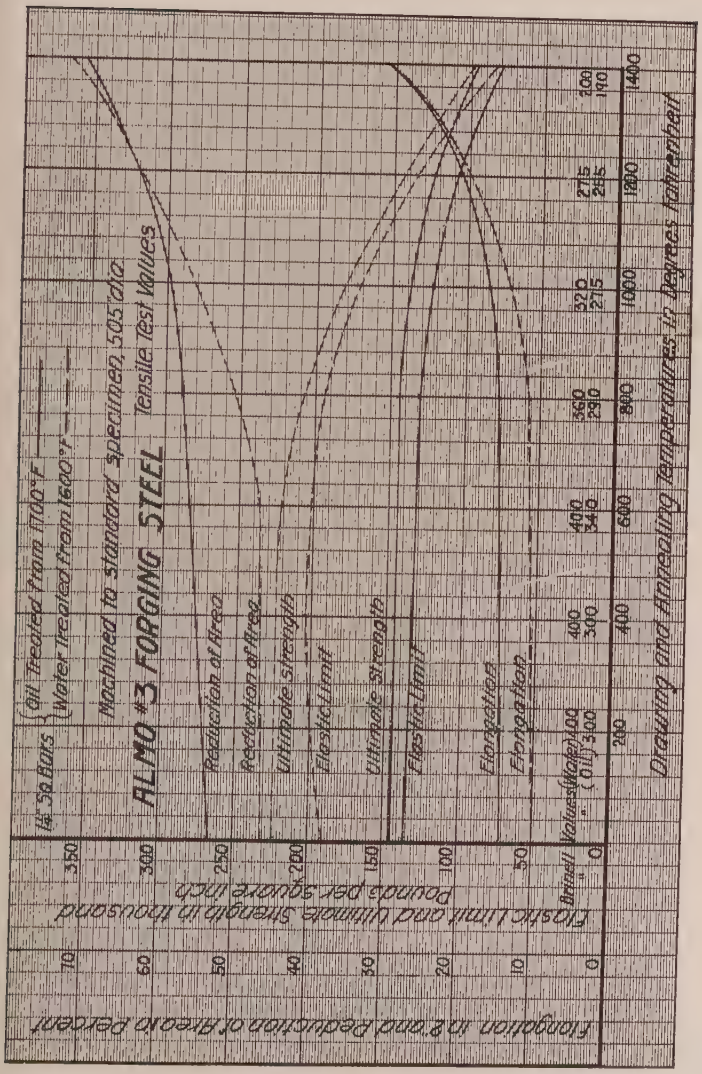
This brand possesses to a remarkable degree the high tensile test values and other physical characteristics of our previously described Almo Steels, and in cases where price of material is of prime importance, it will arouse particular interest.

PHYSICAL CHARACTERISTICS

TENSILE TEST

Annealed Specimen		Toughened Specimen
79,500	Elastic limit, pounds per square inch	114,100
94,000	Ultimate strength, pounds per square inch	134,400
30.5	Elongation in two inches	15
69.8	Reduction of area	57.8
166	Brinell	277

Almo Steels of all types are characterized by freer machining for a given strength or hardness than steels of other types not containing Molybdenum. Conversely, Almo Steels may be machined commercially at considerably greater hardness and strength than is machinable in other alloys. They show very deep hardening in the larger sizes.


ALMO #3 FORGING STEEL
Machined to standard specimen, 505" dia
Tensile Test Values
Oil Treated from 1700°F
Water Treated from 1600°F
Reduction of Area
Reduction of Area
Ultimate Strength
Elastic Limit
Ultimate Strength
Elastic Limit
Elongation
Elongation
Brinell Values (Water) 400 400 360 320 275 200
" (Oil) 300 300 340 290 275 255 190
Drawing and Annealing Temperatures in Degrees Fahrenheit
200 400 600 800 1000 1200 1400
Elastic Limit and Ultimate Strength in thousand Pounds per square inch
0 50 100 150 200 250 300 350
Elongation in 2" and Reduction of Area in Percent
0 10 20 30 40 50 60 70

MOLYBDENUM CASE-HARDENING STEELS

Both Chrome and Nickel Molybdenum have been used for case-hardening parts. The Chrome Molybdenum takes a deep case and hardens very hard, but in order to secure the maximum refinement of case and core in hardening, it is necessary to maintain somewhat closer ranges in heat treatment than are generally considered desirable, at least in large production work. For this reason the use of Nickel Molybdenum has increased and these steels are made in several types, usually containing from one-half of 1% to 1½% of Nickel and with from one-tenth of 1% to one-quarter of 1% Molybdenum.

We are prepared to furnish these individual specifications as the needs of the user may require.

MAXEL FORGING STEEL
MAXEL CASE-HARDENING STEEL

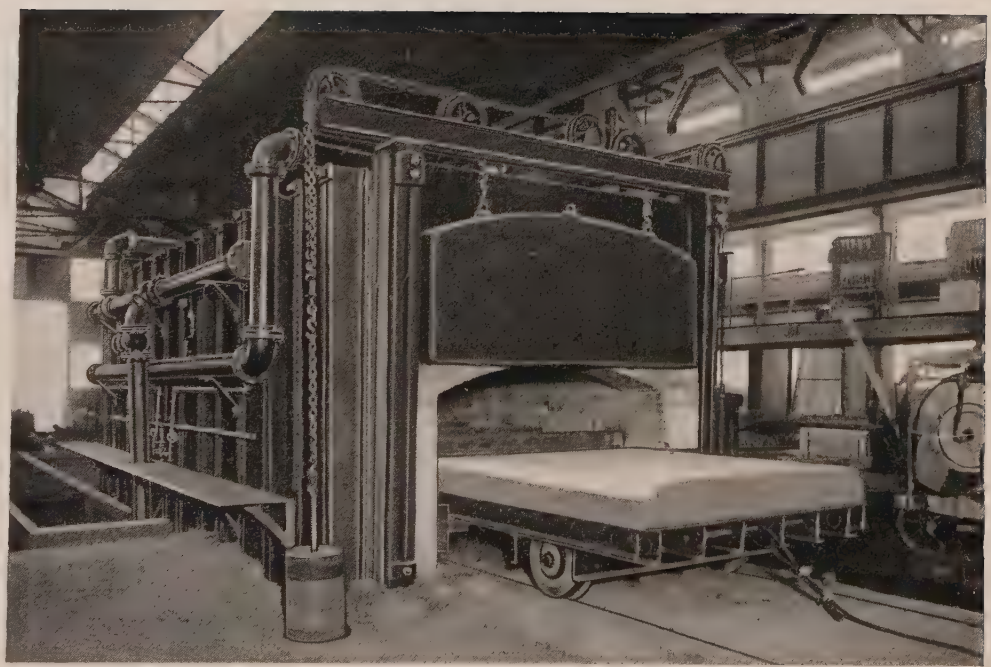
Appreciating the demand for an Alloy Steel capable of developing physical properties and hardness beyond that obtainable from a straight carbon machinery steel, and yet of a more modest price than the standard alloy grades, we have developed this Chrome Manganese Steel.

In the forging grade, which is the higher carbon, it possesses good physical values without any heat treatment whatever. However, it is also capable of developing considerably higher tensile properties by heat treatment; as witness the following:

Physical Properties	Natural Condition	After quenching in oil at 1450° F. and drawing back at the following temperatures		
		1300° F.	1150° F.	850° F.
Tensile Strength.....	110,000 lbs.	110,000 lbs.	135,000 lbs.	205,000 lbs.
Elastic Limit.....	65,000 lbs.	75,000 lbs.	110,000 lbs.	175,000 lbs.
Elongation in 2''.....	16%	25%	20%	10%
Reduction of Area....	40%	65%	54%	36%

The above tests taken on a 1'' rd. bar

This grade is supplied for both forging and case-hardening, the two differing principally in carbon content. In addition to its price value and physical properties, it is somewhat more easily machined than the higher grades of Alloy Steel.



FURNACE FOR ANNEALING STEEL

SPRING STEELS
AND
SPRINGS

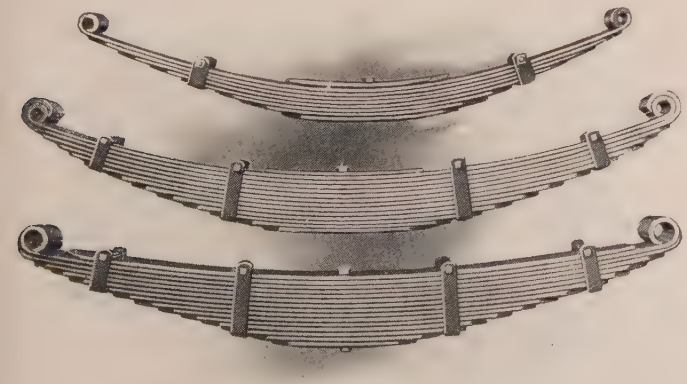
SPRING STEELS AND SPRINGS

ALLOY SPRING STEELS

While investigations up to the present time indicate that the deflection under a given load is more or less the same in all steels, and in any condition of the same, yet alloy steels with their higher elastic limits, combined with greater toughness, produce springs giving the maximum of wearing service and easy riding qualities—features especially desirable in automobiles.

The alloy steel spring will endure the greatest amount of deflection without having the load exceed the elastic limit. It is this quality that permits of a spring so designed that under service conditions it moves through a considerable distance carrying the required load with ease, and an absence of that stiff and quick reaction which characterizes springs made with the less tough and necessarily stiff carbon steel.

It seems, therefore, that the best spring steel is that which readily lends itself to the various operations necessary for the production of the finished spring, and shows in its final condition the ability to withstand, without breaking or yielding, the greatest load coupled with the greatest amount of deflection. Having in mind these facts, we call your attention to the following brands and the table of tests of the same given on the following pages, the values given being very conservatively stated.



ALLOY SPRING STEELS—Continued

DEFLECTION TESTS

Test Specimens..... 2.50 x .259 x 15 inches
Distance between supports..... 10.25 inches

Load was applied midway between supports

	Deflection at Elastic Limit	Load in Pounds	Fibre Stress Per Square Inch
Superior Spring Steel.....	1.006	3,280	301,000
Duplex Spring Steel.....	.953	3,120	286,000
Alva Spring Steel.....	.855	2,800	256,000
Silico-Manganese Spring Steel.....	.860	2,820	258,000

SUPERIOR SPRING STEEL

This steel, for the manufacture of springs, is very superior in that it can be manipulated at high temperatures without suffering material loss of its excellent physical properties, and in that the temperature range for heat treatment is very wide. Consequently the manufacturing losses sustained with the hitherto used alloy steels, through injury to the steel in working or failure to harden and temper, under the exact conditions, are eliminated, all of which renders spring making easier and more economical. The product is a dependable spring of high elastic limit and great toughness, produced at a moderate cost, although the initial price of the steel is relatively higher.

The conservative values in the tables are indicative of the merits of this Superior Spring Steel, which is the last word up to the present time in alloy spring steels.

TENSILE TEST

	Tempered Specimen
Elastic limit, pounds per square inch.....	200,000
Ultimate strength, pounds per square inch.....	220,000
Elongation in two inches.....	13%
Reduction of area.....	45%

DUPLEX SPRING STEEL

This brand is one of the best of the alloy spring steels, as indicated in the preceding table. In it are combined to a high degree those qualities necessary for the production of the high quality spring. The manufacturers who handle this steel, with a little care, will be well repaid for their pains by the admirable results obtained.

TENSILE TEST

	Tempered Specimen
Elastic limit, pounds per square inch	180,000
Ultimate strength, pounds per square inch	210,000
Elongation in two inches	15%
Reduction of area	40%

ALVA SPRING STEEL

This is a Chrome-Vanadium Steel, manufactured with the greatest care and with those considerations so necessary for the successful manufacture of this type of steel. In the form of wire it makes the best gas engine valve springs.

TENSILE TEST

	Tempered Specimen
Elastic limit, pounds per square inch	175,000
Ultimate strength, pounds per square inch	190,000
Elongation in two inches	11%
Reduction of area	30%

SILICO-MANGANESE SPRING STEEL

This brand of spring steel has met with much favor both here and abroad and, if carefully handled, will produce the best spring obtainable from steel of this price, and we heartily recommend it.

TENSILE TEST

	Tempered Specimen
Elastic limit, pounds per square inch	175,000
Ultimate strength, pounds per square inch	195,000
Elongation in two inches	9%
Reduction of area	28%

All of the grades, owing to care in manufacture and inspection, are thoroughly dependable products and may be relied upon as representing the best quality in their respective fields as determined by the physical values needed or desired.

CRUCIBLE SPRING STEEL

The highest grade of Carbon Spring Steel is that produced from Genuine Crucible melted Cast Steel Ingots. It is a clean, sound steel suitable for use in highly stressed parts or for places where good hardening qualities combined with toughness are desired.

Subject to Crucible Spring Steel Classification of Extras, as shown on page 223.

ONYX SPRING STEEL

This represents one of our highest grades of Carbon Spring Steel, being of a Crucible analysis running low in phosphorus and sulphur. The greatest care is exercised in manufacturing this highly specialized grade. We recommend it for purposes where a good high grade Spring Steel is required.

Subject to Crucible Spring Steel Classification of Extras, as shown on page 223.

H. C. SPRING STEEL

This well known grade of Carbon Spring Steel was developed with a view of producing springs requiring special strength and endurance. We particularly recommend it for railroad work where it is called upon to meet severe usage. This grade has been adopted as the standard by a large number of users.

Classification of Extras for size, etc., furnished on application.

CORONA SPRING STEEL

This grade is one of our well known Carbon Spring Steel brands. It has been adopted by a number of manufacturers of vehicle springs who have found the results to be very satisfactory. We recommend it to our customers who are interested in something better than an ordinary Open Hearth Spring Steel grade.

Classification of Extras for size, etc., furnished on application.

CRUCIBLE SPRING STEEL

Standard Classification of Extras
All Dimensions Inclusive
Intermediate sizes take the next higher extra

FLAT

1¼ to 4 inches x No. 4 gauge to ½ inch, inclusive ..... Base

	Extra per Lb. Cents
1 and 1⅛ inches x No. 1 to 4 gauge, inclusive	0.2
1 to 3 inches x No. 5 to 7 " "	0.5
¾ and 15/16 inch x No. 1 to 7 " "	0.5
⅜ to 11/16 inch x No. 1 to 7 " "	1.0
¾ to 3 inches x No. 8 to 10 " "	1.0
¾ to 3 inches x No. 11 to 16 " "	1.5
¾ to 3 inches x No. 17 to 19 " "	2.2
⅜ to ⅝ inch x No. 10 to 16 " "	4.0
⅜ to ⅝ inch x No. 17 to 19 " "	5.0

Thinner than No. 19 gauge, refer to sheet list

ROUND AND SQUARE

⅝ to 1½ inches, inclusive ..... Base

	Extra per Lb. Cents		Extra per Lb. Cents
9/16 and ½ inch	0.2	¼ inch	1.5
7/16 and ⅜ inch	0.5	3/16 inch	3.0
5/16 inch	1.0		

Cutting to lengths 24 inches and over, .20 cents per pound. Under 24 inches, special price.

O.H. SPRING STEEL BARS

EXTRAS FOR SIZE

FLAT

	Extra per Lb. Cents
1¼ to 6 inches x No. 4 gauge to ½ inch, inclusive	Base
1 and 1⅛ inches x No. 1 to No. 4 gauge, inclusive	0.10
1 to 3 inches x No. 5 to No. 7 " "	0.25
¾ and 15/16 inch x No. 1 to No. 7 " "	0.25
⅜ to 11/16 inch x No. 1 to No. 7 " "	0.50
¾ to 3 inches x No. 8 to No. 10 " "	0.50
¾ to 3 inches x No. 11 to No. 16 " "	0.75
¾ to 3 inches x No. 17 to No. 20 " "	1.10
⅜ to ⅝ inch x No. 10 to No. 16 " "	2.00
⅜ to ⅝ inch x No. 17 to No. 20 " "	2.50
⅜ to ⅝ inch x No. 21 to No. 24 " "	3.00

ROUND AND SQUARE

	Extra per Lb. Cents
⅝ to 1½ inches, inclusive	Base
½ to 9/16 inch, inclusive	0.10
⅜ to 7/16 inch, "	0.25
5/16 inch	0.50
¼ and 9/32 inch	0.75

On Intermediate Sizes, the extra for next lighter size will apply.

EXTRAS FOR CUTTING

No charge for shearing to specified lengths 5 feet and over.

Shearing to specified lengths over 2 feet to 5 feet, .10 cents per pound.

Shearing to specified lengths 2 feet and under, subject to special arrangement.

QUANTITY DIFFERENTIALS

All specifications for less than 2000 pounds of a size will be subject to the following extras, the total weight of a size ordered to determine the extra, regardless of length and regardless of exact quantity actually shipped.

	Per Lb.
Quantities less than 2000 pounds but not less than 1000 pounds	.20c
Quantities less than 1000 pounds	.50c

NOTE—This page gives complete list of standard extras, but is not an indication of sizes we are prepared to furnish.

FINISHED SPRINGS

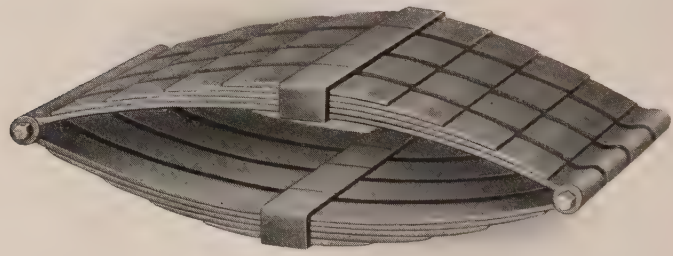
We operate a modern and completely equipped Spring Works, where we manufacture finished springs of all the principal types used on railroad locomotives and cars. These springs are made exclusively from steel melted and rolled in our own mills and subjected to the critical inspection which distinguishes our other products from the ordinary run of materials.

Among the products of this plant are: semi-elliptic springs for engine drivers and trucks, full elliptic springs for passenger cars, elliptic springs of all descriptions for street and interurban cars, helical springs for passenger and freight cars, and miscellaneous types for many industrial uses.

A special repair department in this plant handles the reconditioning of elliptic and semi-elliptic springs. These are completely reworked and re-tempered, new steel being used only where necessary

to replace worn out or defective material. This service to our customers effects a considerable saving to them as compared with the price of new springs.

The product of our Spring Works has established a reputation for excellence and long service among our customers, with whom are numbered many of the most important railroads in the United States.



MACHINERY STEELS

MACHINERY STEELS

CRUCIBLE MACHINERY STEEL

The highest grade of Machinery Steel is that produced from genuine crucible melted cast steel ingots. We furnish this material in various carbons to meet individual requirements. It is a clean, sound steel, suitable for use in highly stressed parts or for places where good hardening qualities, combined with toughness in the hardened part are desired. Its physical properties vary somewhat with the size being produced, but for a steel with three-quarters of 1% carbon, for example, it will show approximately the following physical properties in the natural condition:

Elastic Limit	55,000 to 65,000 lbs.
Ultimate Strength	100,000 to 115,000 lbs.
Elongation	12 to 20%

In the annealed condition it machines readily.
Prices subject to Classification of Extras, as shown on page 230.

ONYX MACHINERY STEEL

The standard Carbon range of this steel is .60 to .70, but we also furnish it in other Carbons to meet Special purposes. It represents one of our highest grades of Machinery Steel, being of a Crucible analysis running low in phosphorus and sulphur. The greatest care is exercised in the manufacture of this highly specialized grade, and we particularly recommend its use for parts that are to be hardened after machining.

In the above standard Carbon range, the physical properties in the natural condition will show approximately as follows:

Elastic Limit	50,000 to 60,000 lbs.
Ultimate Strength	95,000 to 105,000 lbs.

Prices subject to Classification of Extras, as shown on page 230.

CRUCIBLE AND ONYX MACHINERY STEEL

Standard Classification of Extras

All Dimensions Inclusive

Intermediate sizes take the next higher extra

ROLLED ROUND AND SQUARE

	Extra per Lb. Cents
¾ inch to 3 inches	Base
½ to $\frac{11}{16}$ inch	0.3
$\frac{3}{8}$ to $\frac{7}{16}$ inch	0.5
$\frac{5}{16}$ to $\frac{11}{32}$ inch	1.0
¼ and $\frac{9}{32}$ inch	1.5
$\frac{3}{16}$ inch	3.0

HAMMERED ROUND AND SQUARE

3⅛ to 4 inches	1.0
4⅛ to 6 inches	1.5
6⅛ to 7 inches	2.0

FLAT

$\frac{5}{8}$ inch to 2 inches thick by $\frac{9}{16}$ inch to 2 inches wide	Base

The extras for Flat are one-half those of the Flat Carbon Tool Steel Classification.

Cutting to specified single and multiple lengths, 24 inches up to 18 feet, one-half cent per pound. Shorter than 24 inches, according to agreement. Longer than 18 feet, according to agreement.

SPECIAL OPEN HEARTH CARBON STEELS

The requirements for machinery and machine tool construction frequently demand a material of higher quality than can be relied upon in commercial bar steel. To meet this requirement, we call your attention to our Special Open Hearth Carbon Steels made in small basic or acid furnaces. Great care is used in the selection of raw materials and from the beginning to the end of their manufacture these steels are given the closest attenton which is characteristic of tool steel mill production. By these methods we are assured of a product showing the minimum amount of impurities and segregation When safety and dependability are given consideration, even though the requirements may not be such as to demand the use of alloy steels, our Special Open Hearth Carbon Steels—generally known under the trade-name of "Machinery Steels"—will be found satisfactory. The inherent qualities of these grades have brought an increasing demand from the trade and their use has been fully justified, as is proven by the long experience of users.

We can furnish these steels to meet the various S. A. E. specifications, as well as other standard specifications and analyses desired.

EMPIRE MACHINERY STEEL

The standard Carbon range of this steel is .08 to .18. It possesses excellent machining qualities, and is supplied in both Guide Rolled and Planished finish, the latter finish being preferable for Automatic Machine work. This grade is made from carefully selected stock, and is in great demand among users of Soft Machinery Steel for work where high quality is a prerequisite. The care used in the selection of the stock accounts for its fine inherent qualities.

The physical properties are approximately as follows:

Elastic Limit	35,000 to 45,000 Lbs.
Ultimate Strength	55,000 to 66,000 Lbs.

Our Standard Classification of Extras on Steel Bars applies to the above grade and copies may be had on application.

OPEN HEARTH MELTING FURNACE

AURORA CASE-HARDENING STEEL

The standard Carbon range of this steel is .15 to .25. It is produced to meet the demands for a high quality, straight Carbon Case-Hardening Steel. It is very homogeneous, free from slag and oxide. When properly case hardened, it shows a fine grain with a tough core and a hard case. In this state, it possesses good wearing properties, and we highly recommend it for case-hardening parts of various descriptions.

We supply it in both Guide Rolled and Planished finish.

The physical properties of this steel in the natural condition are approximately as follows:

Elastic Limit	35,000 to 45,000 Lbs.
Ultimate Strength	50,000 to 60,000 Lbs.

Our Standard Classification of Extras on Steel Bars applies to the above grade and copies may be had on application.

CALUMET MACHINERY STEEL

The standard Carbon range of this steel is .25 to .35. It has been one of our leading brands for years. The easy machining qualities of Calumet and its toughness and strength are largely due to the fact that the stock from which it is made is of special manufacture and selection, and is sound and uniform. We recommend this steel for parts where a high grade Machinery Steel is essential, and it can be supplied in Guide Rolled or Planished finish.

The physical properties in the natural condition show approximately as follows:

Elastic Limit	40,000 to 50,000 Lbs.
Ultimate Strength	65,000 to 75,000 Lbs.

Our Standard Classification of Extras on Steel Bars applies to the above grade and copies may be had on application.

CORONA MACHINERY STEEL

The standard Carbon range of this steel is .28 to .35. We recommend this grade for parts requiring no special treatment, such as shafts, lead screws, feed screws, bolts, etc., and for work that justifies the use of a high grade Machinery Steel, which will machine freely and produce parts that offer a marked and highly satisfactory resistance to wear.

The difference in price between Corona and the ordinary grades of Machinery Steel on the market is a paying proposition from the standpoint of increased production, and an improved finished product.

We supply this steel in both a Guide Rolled and a Planished finish.

The physical properties are approximately as follows:

Elastic Limit	40,000 to 50,000 Lbs.
Ultimate Strength	70,000 to 80,000 Lbs.

Our Standard Classification of Extras on Steel Bars applies to the above grade and copies may be had on application.

"B" MACHINERY STEEL

The standard Carbon range of this steel is .33 to .40. We particularly recommend it to our customers requiring an easy machining steel of a medium Carbon. It is a good uniform steel, and can be supplied in either Guide Rolled or Planished finish.

The physical properties in the natural condition are approximately as follows:

Elastic Limit	45,000 to 55,000 Lbs.
Ultimate Strength	75,000 to 85,000 Lbs.

Our Standard Classification of Extras on Steel Bars applies to the above grade and copies may be had on application.

CLIMAX MACHINERY STEEL

The standard Carbon range of this steel is .33 to .40. This grade is particularly known for its toughness and strength, and is being used for numerous general purposes by the trade requiring a good dependable grade of steel. It turns and threads easily, and is particularly recommended for such purposes as shafts, gears and other machine parts.

We supply it in both Guide Rolled and Planished finish.

The physical properties in the natural condition are approximately as follows:

Elastic Limit	45,000 to 55,000 Lbs.
Ultimate Strength	75,000 to 85,000 Lbs.

Our Standard Classification of Extras on Steel Bars applies to the above grade and copies may be had on application.

REGENT MACHINERY STEEL

The standard Carbon range of this steel is .40 to .45. It is guaranteed to be uniform, and is recommended for purposes such as high grade shafts, machine parts working under a stress, wood-working machinery forgings, spindles, and other purposes, particularly that are subject to very severe service.

We furnish it Planished finish, very close to size, which is especially suited for Automatic Machine work.

This steel will show, in the natural condition, approximately the following physical properties:

Elastic Limit	45,000 to 55,000 Lbs.
Ultimate Strength	80,000 to 90,000 Lbs.

Our Standard Classification of Extras on Steel Bars applies to the above grade and copies may be had on application.

AJAX MACHINERY STEEL

The standard Carbon range of this steel is .40 to .50. We recommend it to our customers for purposes requiring a selected Machinery Steel for machine parts, shafts, etc. where high physicals are wanted without further treatment. It can be hardened if necessary.

We supply it in both Guide Rolled and Planished finish.

The physical properties in the natural condition are approximately as follows:

Elastic Limit	50,000 to 60,000 Lbs.
Ultimate Strength	85,000 to 100,000 Lbs.

Our Standard Classification of Extras on Steel Bars applies to the above grade and copies may be had on application.

NIAGARA MACHINERY STEEL

The standard Carbon range of this steel is .45 to .55. It is recommended for purposes where toughness and stiffness are required, particularly for forgings, etc. It is reasonably free machining in the natural condition, and is readily machinable in the annealed state. This steel can be hardened in oil or water, and is supplied by us in both the Guide Rolled and Planished finish.

In the natural condition, the steel shows approximately the following physical properties:

Elastic Limit	50,000 to 60,000 Lbs.
Ultimate Strength	75,000 to 95,000 Lbs.

Our Standard Classification of Extras on Steel Bars applies to the above grade, and copies may be had on application.

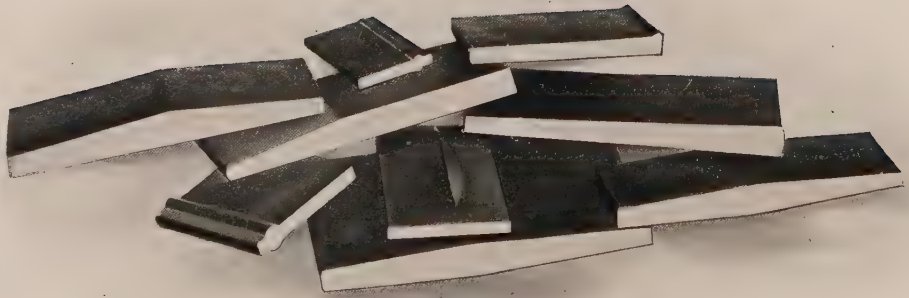
PAPER MILL MACHINERY STEELS

JORDAN BAR or FILLING STEEL, both
PLAIN and BEADED, FINNED or BARBED
BED PLATE STEEL, all WIDTHS and GAUGES
BEATER and FLY BAR STEEL
LAID BAR and FACING STEEL
DOCTOR BLADE STEEL
SOFT BARS for WELDING

These trade designations cover the bulk of the steel under which our "La Belle" Paper Mill Machinery products are sold. We can furnish steel for the vital parts of paper and pulp mill machinery which will "stand the test of time" of hard and severe usage.

In addition to our plain Carbon Steels, so well known and universally used in the past, we have developed and are prepared to supply Alloy Steels (either natural or heat treated ready for use) for those parts of paper and pulp mill machinery where the heaviest duty is required. Great economies are effected by the use of our Alloy Steels, because replacements are much less frequent, and the machines can be maintained at maximum capacity for much longer periods. This important advantage especially interests the paper and pulp manufacturer, as a run of double duration or even longer, is of more value to him than any other detail of his manufacturing operation.

We invite correspondence with interested users.



PAPER MILL MACHINERY STEELS

FORGINGS
AND
ROLLED SPECIAL SHAPES

FORGINGS

Our forging facilities are extensive, complete, and of the most modern character, and our equipment of hammers, presses and furnaces represents the best in forging operations.

The raw materials used are of our own manufacture, our many mills being a never-failing source of supply. Regardless of whether the stock wanted is Crucible, Electric or Open Hearth melting, in either straight carbon or one of the numerous alloy combinations, the same high standard of quality that marks the other products of this Company is fully maintained.

The great advantage derived in having us take care of your forging requirements, whether rough or finished machined, lies in the fact that we control the whole sequence of operations from the melting of the steel to the finished product. This eliminates the annoying question of responsibility which so frequently arises when the steel is made at the plant of one company and the forging and machining done at another.

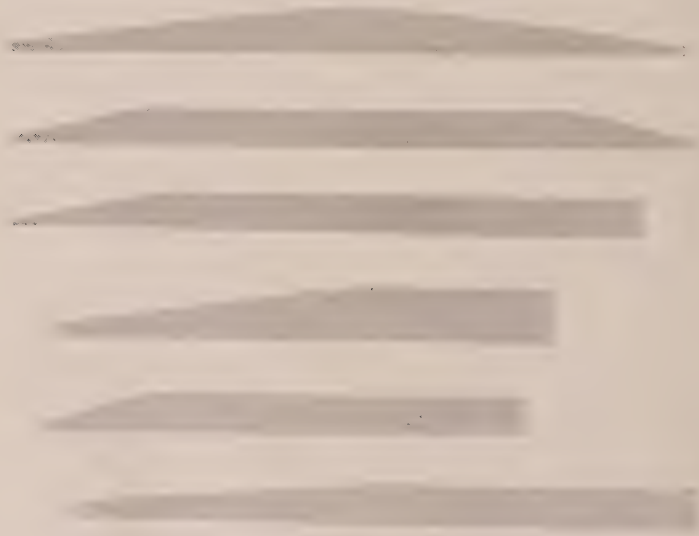
Our modern and extensive machine shop includes a complete machine tool equipment of the latest and most efficient types. We are thus enabled to supply forgings bored, rough turned or finish machined without regard to the size or shape of the forging.

Our smooth forged work has an excellent finish, and as it runs close to size the user has but little stock to remove. As a result of the close working necessary to produce the smooth finish, the structure of these forgings is exceptionally well refined.

The Heat Treatment of our forgings represents a blending of metallurgical knowledge, skillful workmanship and adequate facilities which enable us to meet the most rigid specifications.

ROLLED SPECIAL SHAPES

Builders of special machines, tools or implements, will be interested in the use of steel parts which will reduce labor and manufacturing costs, and at the same time provide qualities which will be absolutely the best for the purpose.



Superior quality is built into these rolled special sections and results in a steel that wears longer than most Straight Carbon Steel. Such shapes can be furnished in heat-treated Alloy Steel, Soft Center Steel and Manganese Steel.

Our facilities on these special shapes are such as will permit us to supply, in a large range of sizes, special sections to meet the most varied requirements.

MAGNET STEELS

PERMANENT MAGNET STEELS

Our Sanderson Works were the first in this country to solve the difficult problem of making uniform High Grade Magnet Steel. Success came after exhaustive study, based on the most advanced metallurgical principles.

Our claim of unexcelled permanent magnetic properties is supported by the fact that we are regularly furnishing Sanderson's Permanent Magnet Steels to the largest makers of Magnetos, Meters, Galvanometers, Radios and similar instruments.

This steel requires expert attention in its manufacture, both as to composition and mechanical treatment, to produce a steel of the utmost uniformity. The success that Sanderson Permanent Magnet Steels have met reflects the high standards which are unfailingly maintained at these Works.

SANDERSON SPECIAL PERMANENT TUNGSTEN MAGNET STEEL

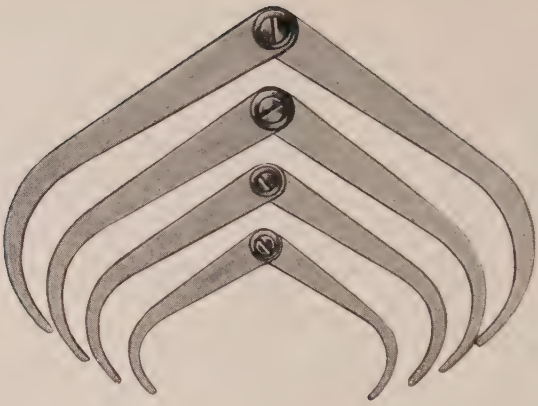
This is a Tungsten Magnet Steel of highest uniformity, possessing a very fine, dense grain and a hardening power to produce maximum residual strength and permanence. It will retain its magnetic qualities indefinitely. It may be readily worked and easily hardened yet has little tendency to check, crack or warp.

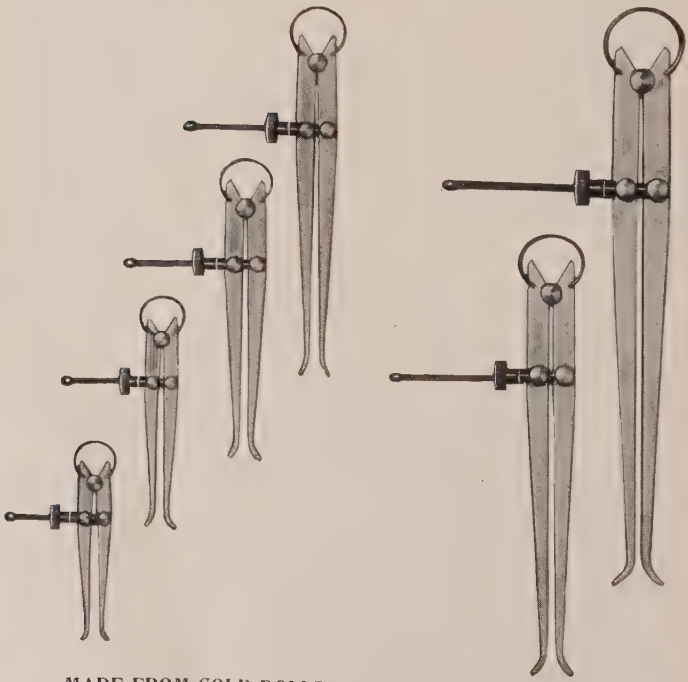
SANDERSON SPECIAL ALLOY MAGNET STEEL

This is a special grade of Magnet Steel and results from its use will show uniformly better magnetic properties than from any other steel of its type, although it is but slightly lower in magnetic properties than the Tungsten Steel mentioned above. It can be hardened very readily in oil or water.

CHROME CARBON MAGNET STEEL CARBON MAGNET STEEL

For magnets where the higher grades above mentioned are not necessary, we are prepared to furnish Chrome Carbon and Straight Carbon Magnet Steels which have proven their suitability for telephone generators and receivers, slot machine magnets and such minor equipment.





MADE FROM COLD ROLLED AND COLD DRAWN STEELS

HIGH GRADE STEEL AND WIRE SPECIALTIES

COLD DRAWN
AND
COLD ROLLED STEELS

CONTINUOUS TEMPERED STEELS
BLACK TEMPERED—POLISHED—
POLISHED AND COLORED
(STRAW OR BLUE)

CRUCIBLE—ELECTRIC—OPEN HEARTH
CARBON AND ALLOY

HIGH GRADE STEEL AND WIRE SPECIALTIES

The Crucible Steel Company of America has modern facilities for Cold Rolling and Cold Drawing all Tool Steels and Alloy Steels enumerated in this catalogue. These include every variety of analysis and finish from the highest quality Crucible and Electric products for Safety Razor Blades, High Grade Needles, Drill Rods, Engineers' Tapes, Band Saw Steels, etc., down to Low Carbon Steel ordinarily termed Soft Cold Rolled Strip and Cold Drawn Machinery Steels.

These steels are adapted to a great variety of purposes. There is scarcely a manufactured product which does not require, either in its assembly or associated with its manufacture, some kind of cold worked steel. To the consumer these products frequently represent an item of serious importance. We are prepared to furnish the steels best suited for a particular purpose. Uniformity of analysis, uniformity of quality and hardness, exactness to size required and perfection of finish are points in manufacture which greatly lessen the ultimate cost. Combined with the ability to satisfy these conditions, particular attention is given to the subsequent operations, blanking quality, forming quality, ease of machining, hardening quality, any of which, if not properly satisfied, renders the steel useless or of very little value.

Detailed attention to the requirements of each individual order has always been our rigid policy. This calls for intimate contact between our manufacturing organization and that of the consumer. Our policy has resulted in the solution of the most difficult problems and enables us to meet the most exacting requirements.

Success in this field is due in a large degree to the control of each step in the manufacture, from the selection of the raw materials for melting, to the final finishing operation. This eliminates the annoying question of responsibility, which so frequently arises when raw materials are made by one company and cold finished by another.

The following pages outline briefly our cold worked products and give references and information to the buyer to assist him in stating his requirements.

TO THE BUYER

To insure the correct execution of orders, observe the following:

Please state,

(1). The purpose for which steel is to be used and the operations it will be required to undergo. In all cases a sample illustrating the operations should accompany the order, especially where the requirements are of an exacting character, or where the operations required cannot easily be explained.

(2). Width and thickness or diameter expressed in the thousandths of an inch. When gauge numbers are used, the name of the gauge and its decimal equivalent should be clearly stated. The gauges most frequently used are compared on pages 292 and 293. Unless otherwise specified, Birmingham Wire Gauge will be used.

(3). Whether round or square edges are required. If round edges, state whether width is to be measured on the flat or over-all.

(4). The permissible variation in size, width, thickness and length. If variation is allowable only one way, state which way.

(5). Whether to be furnished in coils, straight bars or strips. If straight bars or strips are required give the length and multiples, a reasonable percentage of short lengths are always included in shipments.

(6). The Finish required:

(a). Whether ordinary cold rolled or special surface.

(b). Whether ordinary cold drawn, lime drawn or polished.

(c). Whether Black Tempered, Scaleless Blue, Tempered and Polished or Tempered, Polished and Colored (Blue or Straw).

(7). Hardness. State whether for flat work, bending or forming; if either of the latter two, specify the shape —or better, send a sample. If for machining, describe the operation and if possible, state hardness which is satisfactory.

(8). Shipping directions. Boxing, barreling or wrapping will be charged extra. Specify clearly the manner of packing desired.

COLD ROLLED STEELS

The Crucible Steel Company of America in its cold rolling operations confines manufacture to the so-called "Specialty Steels". By this is meant steels for special purposes or of special quality for a purpose. This will be clearly recognized when reviewing the list of classified Specialties on pages 271–272. They embrace every analysis from the highest grade Tool Steel or Alloy Tool Steel, to those steels so low in carbon they cannot be hardened by quenching.

We call your attention to the following grades which are worthy of special mention:

COLD ROLLED TOOL STEELS

Furnished in all grades, tempers, finishes and edges. Particular attention is given to uniformity of analysis, cleanliness and freedom from objectionable decarbonization.

(a). Safety Razor Steel. Carbon or Alloy in condition for blanking or perforating before hardening.
(b). Surgical Instruments.
(c). Dental Instruments.
(d). Hair Clipper and Sheep Clipper Steel. Furnished in three grades, Regular, Special and Alloy.
(e). Slitting Saw Steel. Straight Carbon and Alloy.
(f). Pruning Shear Steel.
(g). Tool Steel for Inserts. Straight Carbon and Alloy.

COLD ROLLED SAW STEELS

After years of research, the Crucible Steel Company of America developed a steel melted by special practice particularly adapted to the manufacture of thin gauge Band Saws or Saws manufactured from a continuous Cold Rolled Strip. These are furnished in all carbon ranges from medium to high carbon and alloy:

(a). Metal Cutting Band Saws.
(b). Butcher Saw Steel.
(c). Wood Band Saw.
(d). Coping Saw.
(e). Jig Saw.

Special attention is given to straightness, proper temper for the purpose, toughness and blanking quality.

COLD ROLLED DIAPHRAGM STEELS

The success of the Automobile Horn depends on the quality of the Horn Diaphragm Steel. The ability to apply the proper steel to the proper horn, combined with the most important factors in assembly, flatness and uniformity, is an achievement of the Crucible Steel Company of America. We guarantee our steel to be flat and free from objectionable buckles and twists.

Furnished in Carbon and Alloy Steels, tempered and untempered, in all gauges and widths up to 6 inches, suitable for hand horns, motor horns and vibratory horns.

TAPE LINE STEELS

For Engineers' and Scientific Measuring Tapes and General Measuring Tapes. A Cold Rolled Tool Steel uniform in temper and gauge, surface highly polished for lustre and for letter etching.

CLOCK SPRING STEELS

Furnished in all gauges and widths, untempered and tempered.

GOLF SHAFT AND FISH POLE STEELS

In arriving at the proper analysis and finish, attention has been devoted to forming quality and hardening quality, capable of withstanding difficult forming operations.

WRITING PEN STEELS

A Cold Rolled Tool Steel rolled in thin gauges, high lustre surface finish, free from objectionable twists and buckles. Furnished dead soft or hard for blanking. Freedom from objectionable decarbonization and uniformity of analysis makes this steel especially suitable for hardening and tempering to produce maximum spring quality.

CHAIN LINK STEELS

All analyses, carbon and alloy, for the manufacture of Automobile Silent Chains, Bicycle and Power Drive Chains. Particular attention is given to surface and uniformity of analysis, insuring uniform test after heat treatment for quality Chains.

NON-MAGNETIC COLD ROLLED STEEL

A special low carbon Steel or Iron suitable for use in Electrical work where retention of residual magnetism is objectionable.

COLD ROLLED LOW CARBON STRIP STEEL

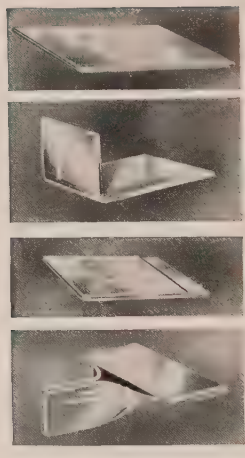
In this range of analysis, commercially termed Cold Rolled Strip Steel, there are innumerable demands for uniformity of size, temper and finish, which cannot be controlled by large tonnage manufacture. This can only be accomplished by skilled workmen applying their knowledge to the individual requirement. This is a specialty for which our facilities are peculiarly adapted.

WORKING LIMITS

To avoid misunderstanding, it is necessary to have an accurate knowledge of our working limits and description of finishes. It will aid the buyer and the mill if orders refer to the numbers as given on pages 254, 255.

COLD ROLLED STEEL

HARDNESS



No. 1—Hard-rolled for easy punching and plain flat work.

No. 2—Medium Hard-rolled to take a sharp right-angle bend across the grain.

No. 3—Soft-rolled to bend down upon itself across the grain.

No. 4—Dead-soft to bend down upon itself both with and across the grain.

The requirements of this class of material vary widely owing to the many kinds of articles into which it is formed by automatic and other kinds of machinery. Therefore, to facilitate intelligent handling of your business, let us have all the available information with the order. If possible, send a sample of the finished article, together with the strip from which it was made.

BRIGHT COLD ROLLED FINISHES

No. 1 Fairly bright and smooth for general use.

No. 2 Bright and smooth for more particular work.

No. 3 Extra bright and smooth for nickel plated and polished products.

These surface finishes, which we produce with great success, readily permit of the adaptation of these steels to the variety of uses for which they are designed.

Cold Rolling is limited to widths not narrower than 1/16 inch nor wider than 12 inches.

COLD ROLLED STEEL

EDGES

No. 1 Regular Edge, ordinary mill finish, suitable for blanking or where accurate edge is not required. Unless otherwise specified, regular edge will be furnished. Maximum variation to be expected is as listed:
Under 2½ inches wide—plus or minus 1/32 inch.
Over 2½ inches wide up to 7 inches wide—plus or minus 3/64 inch.
Over 7 inches wide—plus or minus 1/16 inch.

No. 2 Round Edge, clean and bright, reasonably accurate. This edge is made only on narrow widths up to 7/16 inch.

No. 3 Finished Rolled Edges, round or square, rolled smooth and bright, accurate as to width. Limited to widths not over 1¾ inches.

No. 4 Sheared Edge, square, but not filed, and accurate as to width.

No. 5 Sheared and Filed Edge, square or round, filed by one or more passes on Filing Machine to remove any possible burr, or weakness that might result from a sheared edge. Limited to widths not over 1¾ inches. For unusual requirements it is at times possible to hold closer limits. In such cases special extras will be quoted.

SHIPMENTS

It is customary to ship all Cold Rolled Steel in coils or bundles. If straight lengths are necessary this must be specified when ordering.

COLD DRAWN STEELS

As illustrated under the subject Cold Rolling, these include every variety of analysis and quality, Crucible, Electric and Open Hearth Steels, straight carbon and alloy. The classification "Special" Cold Drawn Steels is confined to limits of diameter or cross section area within our capacity.

SIZE RANGE

We cold draw rounds within the ranges approximately .015 inch diameter to $3\frac{5}{16}$ inches diameter, rectangles and special shapes all cross section areas up to a maximum of approximately 7 square inches. It is possible, in special cases, to work outside of these limits.

TOOL STEELS

We can Cold Draw practically all Tool Steel grades described in this catalogue. Closeness to size, additional refinement due to cold drawing, uniformity of hardness and finish for special machining operations, are essential factors in the manufacture of a large number of tools.

POLISHED DRILL RODS

CRESCENT SPECIAL POLISHED DRILL RODS
SANDERSON SPECIAL POLISHED DRILL RODS
S. AND J. SPECIAL POLISHED DRILL RODS

For small Taps, Reamers, Punches, Twist Drills, Dental Tools, Watch Parts, Machine Parts, Hardened Pins, etc.

Wherever high grade Drill Rods are used these brands are noted for incomparable finish, exactness to size and freedom from decarbonization. These three factors, of great value to the user, represent the highest development in cold drawing and finishing Tool Steels.

Large stocks of the standard sizes are always on hand at our Branches.

We also carry in stock a limited number of sizes of square Special Polished Drill Rods.

ALLOY DRILL RODS

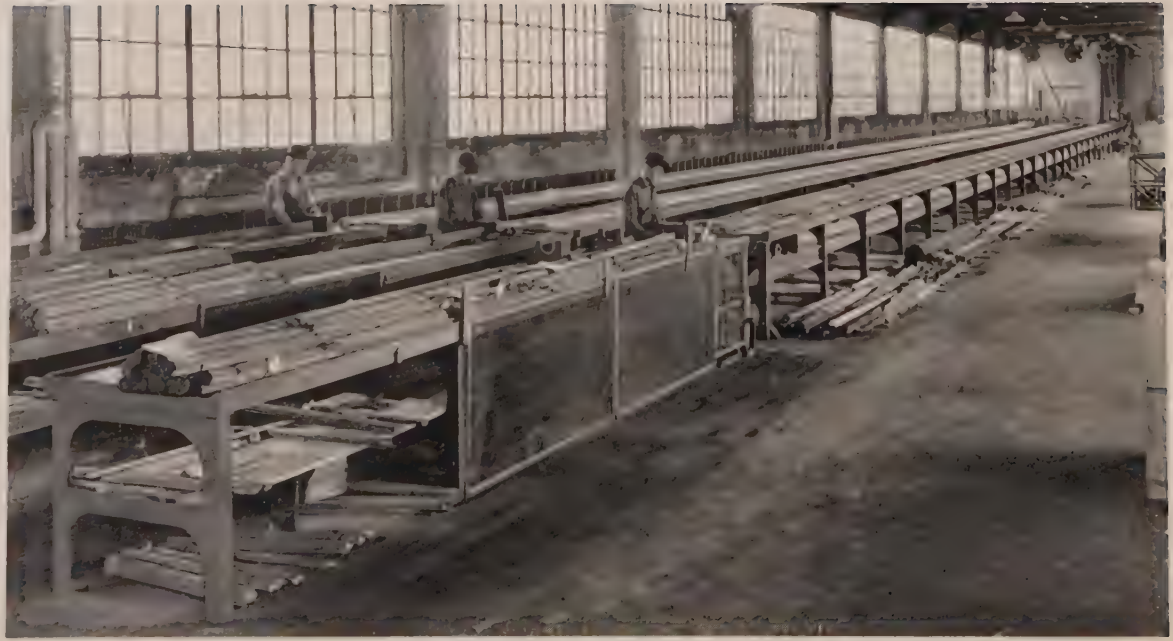
For special purposes we make Alloy Drill Rods of various Alloy Tool Steels such as Alva, Champion Extra, the Non-Changeable brands, Paragon and Champion Non-Changeable, and others as may best fit specific requirements.

VICTOR DRILL RODS

For general use, other than for cutting tools, where a good quality hardening steel is required, demanding the size and finish of Drill Rod. For Shafts, Rollers, Pins, Dowel Pins, Push Rods and other hardened wearing parts, Victor Drill offers many advantages of the higher grade of Drill Rods at a price consistent with the use or application.

All grades can be furnished Lime Drawn. Orders usually require special manufacture.

The Classification on pages 259 to 262 applies to all of the above grades.



STRAIGHTENING AND CUTTING DRILL ROD

ROUND POLISHED DRILL RODS

FOR TAPS, REAMERS, PUNCHES, TWIST DRILLS, DENTAL TOOLS, WATCH PARTS, ELECTRICAL WORK, ETC.

REGULAR LENGTHS, 1 FOOT AND 3 FEET

Nos.	Sizes in Decimals of an Inch	Nearest Sizes in Fractions of an Inch	Prices per Pound	Nos.	Sizes in Decimals of an Inch	Nearest Sizes in Fractions of an Inch	Prices per Pound
	1.500	1 1/2	$0.50		1.031	1 1/32	$0.50
	1.4843	1 31/64	.50		1.015	1 1/64	.50
	1.4687	1 15/32	.50		1.	1	.50
	1.4531	1 29/64	.50		0.984	63/64	.50
	1.4375	1 7/16	.50		0.969	31/32	.50
	1.4218	1 27/64	.50		0.953	61/64	.50
	1.4062	1 13/32	.50		0.937	15/16	.50
	1.3906	1 25/64	.50		0.921	59/64	.50
	1.375	1 3/8	.50		0.906	29/32	.50
	1.3593	1 23/64	.50		0.890	57/64	.50
	1.3437	1 11/32	.50		0.875	7/8	.50
	1.3281	1 21/64	.50		0.859	55/64	.50
	1.3125	1 5/16	.50		0.844	27/32	.50
	1.2968	1 19/64	.50		0.828	53/64	.50
	1.2812	1 9/32	.50		0.812	13/16	.50
	1.2656	1 17/64	.50		0.796	51/64	.50
	1.250	1 1/4	.50		0.781	25/32	.50
	1.2343	1 15/64	.50		0.765	49/64	.50
	1.2187	1 7/32	.50		0.750	3/4	.55
	1.2031	1 13/64	.50		0.734	47/64	.55
	1.1875	1 3/16	.50		0.719	23/32	.55
	1.1718	1 11/64	.50		0.703	45/64	.55
	1.1562	1 5/32	.50		0.687	11/16	.55
	1.1406	1 9/64	.50		0.671	43/64	.55
	1.125	1 1/8	.50		0.656	21/32	.55
	1.1093	1 7/64	.50		0.640	41/64	.55
	1.093	1 3/32	.50		0.625	5/8	.55
	1.078	1 5/64	.50		0.609	39/64	.55
	1.062	1 1/16	.50		0.594	19/32	.55
	1.046	1 3/64	.50		0.578	37/64	.55

ROUND POLISHED DRILL RODS

FOR TAPS, REAMERS, PUNCHES, TWIST DRILLS, DENTAL TOOLS, WATCH PARTS, ELECTRICAL WORK, ETC.

REGULAR LENGTHS, 1 FOOT AND 3 FEET

Nos.	Sizes in Decimals of an Inch	Nearest Sizes in Fractions of an Inch	Prices Per Pound	Nos.	Sizes in Decimals of an Inch	Nearest Sizes in Fractions of an Inch	Prices Per Pound
..	0.562	9/16	$0.55	N	0.302	..	$0.75
..	0.546	35/64	.55	..	0.297	19/64	.75
..	0.531	17/32	.55	M	0.295	..	.75
..	0.515	33/64	.55	L	0.290	..	.75
..	0.500	1/2	.60	K	0.281	9/32	.75
..	0.484	31/64	.60	J	0.277	..	.75
..	0.469	15/32	.60	I	0.272	..	.75
..	0.453	29/64	.60	H	0.266	17/64	.75
..	0.437	7/16	.60	G	0.261	..	.75
..	0.425	..	.75	F	0.257	..	.75
..	0.421	27/64	.75	E	0.250	1/4	.75
Z	0.413	..	.75	D	0.246	..	.75
..	0.406	13/32	.75	C	0.242	..	.75
Y	0.404	..	.75	B	0.238	..	.75
X	0.397	..	.75	A	0.234	15/64	.75
..	0.391	25/64	.75	1	0.227	..	.75
W	0.386	..	.75	2	0.219	7/32	.75
V	0.377	..	.75	3	0.212	..	.75
..	0.375	3/8	.75	4	0.207	..	.75
U	0.368	..	.75	5	0.204	..	.75
..	0.359	23/64	.75	..	0.203	13/64	.75
T	0.358	..	.75	6	0.201	..	.75
S	0.348	..	.75	7	0.199	..	.75
..	0.344	11/32	.75	8	0.197	..	.75
R	0.339	..	.75	9	0.194	..	.75
Q	0.332	..	.75	10	0.191	..	.75
..	0.328	21/64	.75	11	0.188	3/16	.75
P	0.323	..	.75	12	0.185	..	.75
O	0.316	..	.75	13	0.182	..	.75
..	0.312	5/16	.75	14	0.180	..	.75

ROUND POLISHED DRILL RODS

FOR TAPS, REAMERS, PUNCHES, TWIST DRILLS, DENTAL TOOLS, WATCH PARTS, ELECTRICAL WORK, ETC.

REGULAR LENGTHS, 1 FOOT AND 3 FEET

Nos.	Sizes in Decimals of an Inch	Nearest Sizes in Fractions of an Inch	Prices Per Pound	Nos.	Sizes in Decimals of an Inch	Nearest Sizes in Fractions of an Inch	Prices Per Pound
15	0.178	..	$0.75	41	0.095	..	$1.05
16	0.175	..	.83	..	0.094	3/32	1.05
17	0.172	11/64	.83	42	0.092	..	1.05
18	0.168	..	.83	43	0.088	..	1.05
19	0.164	..	.83	44	0.085	..	1.05
20	0.161	..	.83	45	0.081	..	1.05
21	0.157	..	.83	46	0.079	..	1.05
..	0.156	5/32	.83	..	0.078	5/64	1.05
22	0.155	..	.83	47	0.077	..	1.20
23	0.153	..	.83	48	0.075	..	1.20
24	0.151	..	.83	49	0.072	..	1.20
25	0.148	..	.83	50	0.069	..	1.20
26	0.146	..	.83	51	0.066	..	1.45
27	0.143	..	.83	52	0.063	..	1.45
..	0.141	9/64	.83	..	0.0625	1/16	1.45
28	0.139	..	.83	53	0.058	..	1.45
29	0.134	..	.83	54	0.055	..	1.45
30	0.127	..	.83	55	0.050	..	1.80
..	0.125	1/8	.83	..	0.0468	3/64	1.80
31	0.120	..	.90	56	0.045	..	1.80
32	0.115	..	.90	57	0.042	..	1.80
33	0.112	..	.90	58	0.041	..	2.10
34	0.110	..	.90	59	0.040	..	2.10
..	0.109	7/64	.90	60	0.039	..	2.10
35	0.108	..	.90	61	0.038	..	2.40
36	0.106	..	.90	62	0.037	..	2.40
37	0.103	..	.90	63	0.036	..	2.70
38	0.101	..	.90	64	0.035	..	2.70
39	0.099	..	1.05	65	0.033	..	2.70
40	0.097	..	1.05	66	0.032	..	3.00

ROUND POLISHED DRILL RODS

FOR TAPS, REAMERS, PUNCHES, TWIST DRILLS, DENTAL TOOLS, WATCH PARTS, ELECTRICAL WORK, ETC.

REGULAR LENGTHS, 1 FOOT AND 3 FEET

Nos.	Sizes in Decimals of an Inch	Nearest Sizes in Fractions of an Inch	Prices Per Pound	Nos.	Sizes in Decimals of an Inch	Nearest Sizes in Fractions of an Inch	Prices Per Pound
67	0.031	1/32	$3.00	74	0.022	..	$3.90
68	0.030	..	3.00	75	0.020	..	4.05
69	0.029	..	3.30	76	0.018	..	4.20
70	0.027	..	3.30	77	0.016	1/64	4.50
71	0.026	..	3.60	78	0.015	..	4.80
72	0.024	..	3.60	79	0.014	..	5.10
73	0.023	..	3.60	80	0.013	..	5.40

Intermediate sizes to order in quantity not less than 50 pounds of any one size.

SQUARE POLISHED DRILL RODS

Sizes in Decimals of an Inch	Sizes in Fractions of an Inch	Prices Per Pound	Sizes in Decimals of an Inch	Sizes in Fractions of an Inch	Prices Per Pound
0.500	1/2	$1.60	0.250	1/4	$1.60
0.4687	15/32	1.60	0.219	7/32	1.60
0.4375	7/16	1.60	0.1875	3/16	1.60
0.4062	13/32	1.60	0.156	5/32	1.60
0.375	3/8	1.60	0.125	1/8	1.60
0.344	11/32	1.60	0.094	3/32	1.60
0.3125	5/16	1.60	0.062	1/16	1.60
0.281	9/32	1.60	.....	..	....

NEEDLE WIRE

For Latch Needles (round and flat), Latch Wire, Latch Pin Wire, Sewing Machine Needles, Hosiery Spring Needles, Leather Needles, Awls, McKay Needles, Goodyear Needles, etc.

The result of years of research and experience has developed a product of unusual ductility and maximum hardening quality. Capable of being drawn, rolled, swedged and formed into the most delicate needles. This is accomplished without impairing hardness, wearing quality or toughness after heat treatment.

Subject to Classification as shown on pages 265 and 266.

SECTION OF WIRE DEPARTMENT

ROUND CRUCIBLE TOOL STEEL WIRE IN COILS

FOR SEWING MACHINE, GOODYEAR, LATCH, McKAY NEEDLES, AWLS

LIST PRICES IN COILS

Gauge No.	Decimals of an Inch	Prices per Lb.	Gauge No.	Decimals of an Inch	Prices per Lb.
1–11	.....	$0.41	19¾	.037	$0.65
12	.105	.44	20	.0355	.65
13	.0925	.47	20½	.0335	.70
13½	.087	.49	20¾	.0325	.70
14	.080	.49	21	.0315	.70
14½	.076	.50	21½	.030	.76
15	.072	.50	22	.029	.76
15¼	.069	.50	22½	.028	.88
15½	.068	.53	22¾	.027	.88
16	.064	.53	23	.026	.88
16¼	.0625	.53	23½	.025	.97
16⅜	.060	.53	23¾	.024	.97
16½	.058	.56	24	.023	.97
16¾	.0565	.56	24½	.022	1.05
17	.055	.56	25	.021	1.05
17¼	.054	.56	25½	.020	1.20
17½	.052	.59	26	.019	1.20
17¾	.050	.59	26½	.018	1.40
18	.0475	.59	27	.017	1.40
18⅛	.047	.59	27½	.016	2.30
18¼	.046	.59	28	.015	2.30
18½	.044	.62	29	.0145	2.65
18¾	.043	.62	30	.01325	3.60
19	.0415	.62	30½	.012	5.40
19½	.039	.65	31	.011	5.40
19⅝	.0385	.65	32	.010	6.10

⅛ and ¼ sizes same price as next larger. ½ and ¾ sizes same price as next smaller.

ROUND CRUCIBLE TOOL STEEL WIRE IN COILS

FOR HOSIERY SPRING NEEDLES

LIST PRICES IN COILS

Gauge No.	Decimals of an Inch	Prices per Lb.	Gauge No.	Decimals of an Inch	Prices per Lb.
1–11	.....	$0.50	19¾	.037	$0.78
12	.105	.53	20	.0355	.78
13	.0925	.57	20½	.0335	.85
13½	.087	.59	20¾	.0325	.85
14	.080	.59	21	.0315	.85
14½	.076	.60	21½	.030	.93
15	.072	.60	22	.029	.93
15¼	.069	.60	22½	.028	1.00
15½	.068	.64	22¾	.027	1.00
16	.064	.64	23	.026	1.00
16¼	.0625	.64	23½	.025	1.08
16⅜	.060	.64	23¾	.024	1.08
16½	.058	.67	24	.023	1.08
16¾	.0565	.67	24½	.022	1.19
17	.055	.67	25	.021	1.19
17¼	.054	.67	25½	.020	1.29
17½	.052	.71	26	.019	1.29
17¾	.050	.71	26½	.018	1.46
18	.0475	.71	27	.017	1.46
18⅛	.047	.71	27½	.016	2.35
18¼	.046	.71	28	.015	2.35
18½	.044	.75	29	.0145	2.70
18¾	.043	.75	30	.01325	3.60
19	.0415	.75	30½	.012	5.40
19½	.039	.78	31	.011	5.40
19⅝	.0385	.78	32	.010	6.10

⅛ and ¼ sizes same price as next larger. ½ and ¾ sizes same price as next smaller.

COLD DRAWN SHAPES.

We have developed a wide variety of Special Shapes which formerly were machined from bar stock. Each year there is added to the list of possible shapes to draw, some that were considered impossible. We will be glad to investigate your requirements.

VALVE SPRING STEELS

Carbon and Alloy. All analyses furnished in two general grades called Regular and Special Valve Spring Steel. The development of the Automobile and Truck Engine has prompted us to develop a steel of great uniformity and maximum strength.

BALL STEEL

A high quality Tool Steel, both Carbon and Alloy. Furnished in coils and bars, either annealed unusually soft for Cold Swedging or in the natural condition for Hot Pressing. We make Ball Steel within close limits, eliminating to a maximum degree decarbonization and surface defects.

KEY STEEL

For Automobile Shafts and general purposes. Special attention is given to accuracy of size and shape. Furnished in all analyses for case hardening, oil hardening or water hardening.

COLD DRAWN HEAT TREATED STEELS

For Axle Shafts, Studs, Bolts, Nuts, Torsion Rods and similar purposes. Furnished in Carbon and all Alloys. Accurate to size and finish. In condition for ease of machining with maximum strength required for the purpose.

WELDING ROD

We cold draw a wide variety of analyses for all purposes. Our specially prepared stocks have enabled us to build up a high standard of quality.

COLD DRAWN STEEL FINISHES

FINISH:

1. Rough drawn.
2. Smooth surface, ordinary drawn finish.
3. Lime drawn.
4. Cold drawn and polished.
5. Cold drawn, polished and ground. This finish applies only in special cases within a limited range of sizes.

HARDNESS:

Great care must be exercised in specifying hardness desired. Ease of machining and finish of the machined part is dependent in large degree upon the amount of hardness after cold working. This can be varied accurately within a wide range by the amount of final reduction in cold drawing. Hardness varies from dead soft annealed to full heat treated.

ACCURACY:

It is possible to cold draw steels very accurate to size. General practice has established a commercial tolerance plus or minus .001 to .0015, depending upon the size and the quality. All quotations will be based on commercial tolerance. Extras will be quoted for tolerances smaller than commercial.

TEMPERED STEELS

The Crucible Steel Company of America is one of the pioneers in the development of the art of hardening and tempering delicate Cold Rolled and Cold Drawn Tool Steels and quality Spring Steel. Each heating unit is controlled by the most modern pyrometric system, permitting great accuracy and uniformity of temper.

Thoroughly trained inspectors and skilled workmen give particular attention to all details necessary to make tempered products a success, such as; straightness, flatness, freedom from hardening pits, uniform polish and color. Each coil is tested and inspected to meet specification for the particular purpose.

We are equipped to continuously temper any of our Cold Drawn or Cold Rolled products where the size will permit. Some of these which are exclusively the result of the continuous tempering art are:

Safety Razor Steel. One of the most difficult Tool Steels to Cold Roll and temper. Hardness must be developed capable of retaining a shaving edge and tough enough to withstand the operations of grinding and honing in the continuous strip.

Tape Line Steel. For Engineers' Tapes, Scientific Measuring Instruments and for general purposes.

Rule Steels. Furnished in all widths and gauges for Flexible Rules, Carpenters' Rules, Engineers' Rules, Square Blades, etc.

Heddle and Loom Wire. The Heddle Frame and Loom maker require a product of high quality, accurate to size and uniform in temper. We specialize in Heddle and Loom Wire of quality and accuracy.

Clock Spring Steels. Where accuracy of size, uniformity of temper and quality of finish are required.

Motor Spring Steels. Developed to maximum degree of uniformity in temper and strength.

Valve Spring Steels. Carbon and Alloy, tempered for coiling. These steels do not require further tempering but have the physical values required for service.

Saw Steels. The major requirements, straightness, flatness, freedom from pits, and high lustre finish are properly satisfied. These steels are tempered for use in continuous Wood Band Saws, Metal Cutting Band Saws and Butcher Saws. Furnished in either Carbon or Alloy. Tempered for easy blanking, tough to resist tooth breakage, hard for a long life in service.

Capacity. All sizes from very thin narrow widths up to flats 6 inches wide, rounds up to 7/16 inch.

All tempered products can be furnished either in cut lengths or coils.

CAUTION.—Be sure to specify finish:

No. 1 Black Tempered

No. 2 Tempered and Polished

No. 3 Tempered, Polished and Colored (Straw or Blue)

No. 4 Whether lengths or coils.

CLASSIFIED LIST OF COLD ROLLED, COLD DRAWN AND TEMPERED SPECIALTIES

Arbor Steel
Arch Support
Awl Wire
Axle Steel
Automobile Horn Steel

Ball Steel
Ball Race
Bell Steel
Brush Wire
Bushing Steel

Calculating Machine Parts
Caliper Leg Steel
Car Seat Steel
Center Drill
Chain Link Steel
Cigar Cutter Steel
Clock Part Steels
Clock Spring
Cloth Cutters
Cold Rolled Low Carbon Strip Steel
Corset Steel
Curtain Rod Steel
Cutlery Steels
Cutting Appliances

Diaphragm Steel
Divider Steel
Dental Instruments
Drill Rod, all grades

Ferrule Steel
Fishing Pole
Fish Hook
Flexible File

Golf Shaft
Gong Steel
Gun Parts

High Speed Steel
Heddle Steel
Hat Wire
Hack Saw Frame
Hair Clipper
Hanger Steel
Hardware Steels
Hosiery Needle Wire

Key Steel
Knitting Needle Steel

Latch Needle Steel
Lock Spring

Main Spring Steel
Manicure Implements
Micrometer Screw
Motor Spring

Needle Bar
Needle Wire
Nail Clipper
Nail Set
Non-Magnetic Iron

CLASSIFIED LIST OF COLD ROLLED, COLD DRAWN AND TEMPERED SPECIALTIES—Continued.

Paragon Wire
Pen Holder
Pen Steel
Pencil Sharpeners
Pile Wire
Printers' Rule
Pruning Shear Steel
Punch Steel

Razor Blade Back Steel
Razor Blade Steel
Rule Steel

Sash Balance
Saw—Butcher
Saw—Coping
Saw—Hack
Saw—Metal Band
Saw—Wood Band
Screw Driver
Screw Stock
Shade Roller
Shoe Shank Steel
Shear Steel
Skate Steel
Slotting Saw
Square Blade
Spring Steels, all analyses

Tool Steels, all analyses
Tape Line
Tube Steel
Type Bar
Type Steel
Typewriter Steels
Telephone Steels

Valve Spring

Winding Arbor
Watch Spring
Watch Parts Steels
Welding Rods

STANDARD TABLES
AND
USEFUL INFORMATION

S. A. E. STEEL SPECIFICATIONS

CARBON STEELS

S. A. E. Steel No.	Carbon Range	Manganese Range	Phosphorus, Max.	Sulphur, Max.
1010	0.05–0.15	0.30–0.60	0.045	0.05
1015	0.10–0.20	0.30–0.60	0.045	0.05
1020	0.15–0.25	0.30–0.60	0.045	0.05
1025	0.20–0.30	0.50–0.80	0.045	0.05
1030	0.25–0.35	0.50–0.80	0.045	0.05
1035	0.30–0.40	0.50–0.80	0.045	0.05
1040	0.35–0.45	0.50–0.80	0.045	0.05
1045	0.40–0.50	0.50–0.80	0.045	0.05
1046	0.40–0.50	0.30–0.50	0.045	0.05
1050	0.45–0.55	0.50–0.80	0.045	0.05
1095	0.90–1.05	0.25–0.50	0.040	0.05
1350	0.45–0.55	0.90–1.20	0.040	0.05
1360	0.55–0.70	0.90–1.20	0.040	0.05

SCREW STOCK

S. A. E. Steel No.	Carbon Range	Manganese Range	Phosphorus, Max.	Sulphur Range
1112	0.08–0.16	0.60–0.80	0.09–0.13	0.075–0.15
1120	0.15–0.25	0.60–0.90	Max. 0.06	0.075–0.15

NICKEL STEELS

S. A. E. Steel No.	Carbon Range	Manganese Range	Phosphorus, Max.	Sulphur, Max.	Nickel Range
2315	0.10–0.20	0.30–0.60	0.04	0.045	3.25–3.75
2320	0.15–0.25	0.50–0.80	0.04	0.045	3.25–3.75
2330	0.25–0.35	0.50–0.80	0.04	0.045	3.25–3.75
2335	0.30–0.40	0.50–0.80	0.04	0.045	3.25–3.75
2340	0.35–0.45	0.50–0.80	0.04	0.045	3.25–3.75
2345	0.40–0.50	0.50–0.80	0.04	0.045	3.25–3.75
2350	0.45–0.55	0.50–0.80	0.04	0.045	3.25–3.75
2512	Max. 0.17	0.30–0.60	0.04	0.045	4.50–5.25

S. A. E. STEEL SPECIFICATIONS

NICKEL CHROMIUM STEELS

S.A.E. Steel No.	Carbon Range	Manganese Range	Phosphorus, Max.	Sulphur, Max.	Nickel Range	Chromium Range
3115	0.10–0.20	0.30–0.60	0.04	0.045	1.00–1.50	0.45–0.75
3120	0.15–0.25	0.30–0.60	0.04	0.045	1.00–1.50	0.45–0.75
3125	0.20–0.30	0.50–0.80	0.04	0.045	1.00–1.50	0.45–0.75
3130	0.25–0.35	0.50–0.80	0.04	0.045	1.00–1.50	0.45–0.75
3135	0.30–0.40	0.50–0.80	0.04	0.045	1.00–1.50	0.45–0.75
3140	0.35–0.45	0.50–0.80	0.04	0.045	1.00–1.50	0.45–0.75
3215	0.10–0.20	0.30–0.60	0.04	0.040	1.50–2.00	0.90–1.25
3220	0.15–0.25	0.30–0.60	0.04	0.040	1.50–2.00	0.90–1.25
3230	0.25–0.35	0.30–0.60	0.04	0.040	1.50–2.00	0.90–1.25
3240	0.35–0.45	0.30–0.60	0.04	0.040	1.50–2.00	0.90–1.25
3245	0.40–0.50	0.30–0.60	0.04	0.040	1.50–2.00	0.90–1.25
3250	0.45–0.55	0.30–0.60	0.04	0.040	1.50–2.00	0.90–1.25
3312	Max. 0.17	0.30–0.60	0.04	0.040	3.25–3.75	1.25–1.75
3325	0.20–0.30	0.30–0.60	0.04	0.040	3.25–3.75	1.25–1.75
3335	0.30–0.40	0.30–0.60	0.04	0.040	3.25–3.75	1.25–1.75
3340	0.35–0.45	0.30–0.60	0.04	0.040	3.25–3.75	1.25–1.75
3415	0.10–0.20	0.45–0.75	0.04	0.040	2.75–3.25	0.60–0.95
3435	0.30–0.40	0.45–0.75	0.04	0.040	2.75–3.25	0.60–0.95
3450	0.45–0.55	0.45–0.75	0.04	0.040	2.75–3.25	0.60–0.95

CHROMIUM STEELS

S. A. E. Steel No.	Carbon Range	Manganese Range	Phosphorus, Max.	Sulphur, Max.	Chromium Range
5120	0.15–0.25	0.30–0.60	0.04	0.045	0.60–0.90
5140	0.35–0.45	0.50–0.80	0.04	0.045	0.80–1.10
5150	0.45–0.55	0.50–0.80	0.04	0.045	0.80–1.10
52100	0.95–1.10	0.20–0.50	0.03	0.030	1.20–1.50

S. A. E. STEEL SPECIFICATIONS

CHROMIUM-VANADIUM STEELS

S. A. E. Steel No.	Carbon Range	Manganese Range	Phosphorus Max.	Sulphur, Max.	Chromium Range	Vanadium	
						Min.	Desired
6120	0.15–0.25	0.50–0.80	0.04	0.04	0.80–1.10	0.15	0.18
6125	0.20–0.30	0.50–0.80	0.04	0.04	0.80–1.10	0.15	0.18
6130	0.25–0.35	0.50–0.80	0.04	0.04	0.80–1.10	0.15	0.18
6135	0.30–0.40	0.50–0.80	0.04	0.04	0.80–1.10	0.15	0.18
6140	0.35–0.45	0.50–0.80	0.04	0.04	0.80–1.10	0.15	0.18
6145	0.40–0.50	0.50–0.80	0.04	0.04	0.80–1.10	0.15	0.18
6150	0.45–0.55	0.50–0.80	0.04	0.04	0.80–1.10	0.15	0.18
6195	0.90–1.05	0.20–0.45	0.03	0.03	0.80–1.10	0.15	0.18

TUNGSTEN STEELS

S. A. E. Steel No.	Carbon Range	Manganese, Max.	Phosphorus, Max.	Sulphur, Max.	Chromium Range	Tungsten Range
71360	0.50–0.70	0.30	0.035	0.035	3.00–4.00	12.00–15.00
71660	0.50–0.70	0.30	0.035	0.035	3.00–4.00	15.00–18.00
7260	0.50–0.70	0.30	0.035	0.035	0.50–1.00	1.50– 2.00

SILICO-MANGANESE STEELS

S. A. E. Steel No.	Carbon Range	Manganese Range	Phosphorus, Max.	Sulphur, Max.	Silicon Range
9250	0.45–0.55	0.60–0.90	0.045	0.045	1.80–2.20
9260	0.55–0.65	0.60–0.90	0.045	0.045	1.80–2.20

HANDY SHOP METHOD TO ESTIMATE APPROXIMATE WEIGHT OF STEEL BARS

ROUNDS

Multiply diameter of bar by 4. Square the result, and divide by 6. For example:

Size 3″ Rd.— 3 x 4 = 12
12 x 12 = 144
144 ÷ 6 = 24# per foot.

SQUARES

Square the section and add a cipher. This gives the weight per yard. Divide by 3 to get weight per foot. For example:

Size 4″ Square—4 x 4 = 16
Add a cipher = 160# per yd.
160 ÷ 3 = 53.33# per foot.

FLATS

Multiply the width by thickness. Add a cipher and divide by 3. For example:

Size 4″ x 1″—4 x 1 = 4
Add a cipher = 40
40 ÷ 3 = 13.33# per foot.

AREAS OF SQUARE AND ROUND BARS

Thickness or Diam. in Inches	Area of Square Bar in Sq. Inches	Area of Round Bar in Sq. Inches	Thickness or Diam. in Inches	Area of Square Bar in Sq. Inches	Area of Round Bar in Sq. Inches
1/16	.0039	.0031	3 1/2	12.250	9.6211
1/8	.0156	.0123	3 5/8	13.141	10.321
3/16	.0352	.0276	3 3/4	14.063	11.045
1/4	.0625	.0491	3 7/8	15.016	11.793
5/16	.0977	.0767	4	16.000	12.566
3/8	.1406	.1104	4 1/8	17.016	13.364
7/16	.1914	.1503	4 1/4	18.063	14.186
1/2	.2500	.1963	4 3/8	19.141	15.033
9/16	.3164	.2485	4 1/2	20.250	15.904
5/8	.3906	.3068	4 5/8	21.391	16.800
11/16	.4727	.3712	4 3/4	22.563	17.721
3/4	.5625	.4418	4 7/8	23.766	18.665
13/16	.6602	.5185	5	25.000	19.635
7/8	.7656	.6013	5 1/8	26.266	20.629
15/16	.8789	.6903	5 1/4	27.563	21.648
1	1.0000	.7854	5 3/8	28.891	22.691
1 1/16	1.1289	.8866	5 1/2	30.250	23.758
1 1/8	1.2656	.9940	5 5/8	31.641	24.851
1 3/16	1.4102	1.1075	5 3/4	33.063	25.967
1 1/4	1.5625	1.2272	5 7/8	34.516	27.109
1 5/16	1.7227	1.3530	6	36.000	28.274
1 3/8	1.8906	1.4849	6 1/8	37.516	29.465
1 7/16	2.0664	1.6230	6 1/4	39.063	30.680
1 1/2	2.2500	1.7671	6 3/8	40.641	31.919
1 9/16	2.4414	1.9175	6 1/2	42.250	33.183
1 5/8	2.6406	2.0739	6 5/8	43.891	34.472
1 11/16	2.8477	2.2365	6 3/4	45.563	35.785
1 3/4	3.0625	2.4053	6 7/8	47.266	37.122
1 13/16	3.2852	2.5802	7	49.000	38.485
1 7/8	3.5156	2.7612	7 1/8	50.766	39.871
1 15/16	3.7539	2.9483	7 1/4	52.563	41.283
2	4.0000	3.1416	7 3/8	54.391	42.718
2 1/16	4.2539	3.3410	7 1/2	56.250	44.179
2 1/8	4.5156	3.5466	7 3/4	60.063	47.173
2 3/16	4.7852	3.7583	8	64.000	50.266
2 1/4	5.0625	3.9761	8 1/4	68.063	53.456
2 5/16	5.3477	4.2000	8 1/2	72.250	56.745
2 3/8	5.6406	4.4301	8 3/4	76.563	60.132
2 7/16	5.9414	4.6664	9	81.000	63.617
2 1/2	6.2500	4.9087	9 1/4	85.563	67.201
2 9/16	6.5664	5.1573	9 1/2	90.250	70.882
2 5/8	6.8906	5.4119	9 3/4	95.063	74.662
2 11/16	7.2227	5.6727	10	100.00	78.540
2 3/4	7.5625	5.9396	10 1/4	105.06	82.516
2 13/16	7.9102	6.2126	10 1/2	110.25	86.590
2 7/8	8.2656	6.4918	10 3/4	115.56	90.763
2 15/16	8.6289	6.7771	11	121.00	95.033
3	9.0000	7.0686	11 1/4	126.56	99.402
3 1/8	9.7656	7.6699	11 1/2	132.25	103.87
3 1/4	10.563	8.2958	11 3/4	138.06	108.43
3 3/8	11.391	8.9462	12	144.00	113.09

BAR STEEL

WEIGHT PER LINEAL FOOT IN POUNDS

Size	Round	Square	Hexagon	Octagon
1/8"	.04	.05	.05	.04
3/16"	.09	.12	.10	.10
1/4"	.17	.21	.19	.18
5/16"	.26	.33	.29	.28
3/8"	.38	.48	.42	.40
7/16"	.51	.65	.57	.54
1/2"	.67	.85	.75	.70
9/16"	.85	1.08	.94	.89
5/8"	1.04	1.33	1.17	1.10
11/16"	1.27	1.61	1.41	1.33
3/4"	1.50	1.92	1.68	1.58
13/16"	1.76	2.24	1.97	1.83
7/8"	2.04	2.60	2.29	2.16
15/16"	2.35	3.06	2.62	2.48
1 "	2.67	3.40	2.99	2.82
1 1/8"	3.38	4.30	3.78	3.56
1 1/4"	4.17	5.31	4.66	4.40
1 3/8"	5.05	6.43	5.65	5.32
1 1/2"	6.01	7.65	6.72	6.34
1 5/8"	7.05	8.98	7.89	7.32
1 3/4"	8.18	10.40	9.14	8.64
1 7/8"	9.38	11.90	10.50	9.92
2 "	10.71	13.60	11.95	11.28
2 1/8"	12.05	15.40	13.49	12.71
2 1/4"	13.60	17.20	15.12	14.24
2 3/8"	15.10	19.20	16.85	15.88
2 1/2"	16.68	21.20	18.66	17.65

WEIGHT of HIGH SPEED STEEL.—The weight of High Speed Steel is approximately 10% heavier than Carbon Tool Steel.

BAR STEEL

WEIGHT PER LINEAL FOOT IN POUNDS

Size	Round	Square	Hexagon	Octagon
2 5/8"	18.39	23.50	20.58	19.45
2 3/4"	20.18	25.70	22.59	21.28
2 7/8"	22.06	28.20	24.69	23.28
3 "	24.10	30.60	26.88	25.36
3 1/8"	26.12	33.13	29.16	27.50
3 1/4"	28.30	35.90	31.55	29.28
3 3/8"	30.45	38.64	34.00	32.10
3 1/2"	32.70	41.60	36.59	34.56
3 5/8"	35.20	44.57	39.24	37.05
3 3/4"	37.54	47.80	42.00	39.68
4 "	42.72	54.40	47.78	45.12
4 1/4"	48.30	61.40	53.95	50.84
4 1/2"	54.60	68.90	60.48	56.96
4 3/4"	60.30	76.70	67.39	63.52
5 "	66.80	85.00	74.66	70.60
5 1/4"	73.60	93.70	82.32	77.80
5 1/2"	80.80	102.80	90.36	85.15
5 3/4"	88.30	112.40	98.76	93.12
6 "	96.10	122.40	107.52	101.45
6 1/2"	113.20	143.60	126.20	117.12
7 "	130.80	166.40	146.36	138.24
8 "	170.88	217.60	191.12	180.48
9 "	218.40	275.60	241.92	227.84
10 "	267.20	340.00	298.64	282.40
11 "	323.00	411.20	361.44	340.60
12 "	384.00	489.60	470.08	405.80

WEIGHT of HIGH SPEED STEEL.—The weight of High Speed Steel is approximately 10% heavier than Carbon Tool Steel.

WEIGHT OF FLAT BAR STEEL, PER LINEAL FOOT

Thickness Inches	WIDTH—INCHES																								
	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4	4 1/2	4 3/4	5
1/16	.1060	.1381	.1594	.1859	.212	.2391	.2656	.292	.319	.346	.372	.425	.478	.531	.584	.638	.691	.744	.80	.85	.90	.96	1.01	1.06
1/8	.2125	.2656	.3188	.3720	.4250	.4782	.5312	.585	.638	.692	.744	.850	.96	1.06	1.17	1.28	1.38	1.49	1.59	1.70	1.81	1.91	2.02	2.13
3/16	.319	.399	.478	.558	.638	.717	.797	.875	.957	1.04	1.15	1.28	1.44	1.59	1.75	1.91	2.07	2.23	2.39	2.55	2.71	2.87	3.03	3.19
1/4	.425	.531	.636	.743	.850	.957	1.06	1.17	1.28	1.38	1.49	1.79	1.92	2.12	2.34	2.55	2.76	2.98	3.19	3.40	3.61	3.83	4.04	4.25
5/16	.531	.664	.797	.929	1.06	1.20	1.33	1.46	1.59	1.73	1.86	2.12	2.39	2.65	2.92	3.19	3.45	3.72	3.99	4.25	4.52	4.78	5.05	5.31
3/8	.638	.797	.957	1.116	1.28	1.43	1.59	1.76	1.92	2.08	2.23	2.55	2.87	3.19	3.51	3.83	4.15	4.47	4.78	5.10	5.42	5.74	6.06	6.38
7/16	.744	.929	1.116	1.302	1.49	1.68	1.86	2.05	2.23	2.42	2.60	2.98	3.35	3.72	4.09	4.46	4.83	5.20	5.58	5.95	6.32	6.70	7.07	7.44
1/2	.850	1.06	1.275	1.487	1.70	1.92	2.12	2.34	2.55	2.72	2.98	3.40	3.83	4.25	4.67	5.10	5.53	5.95	6.38	6.80	7.22	7.65	8.08	8.50
9/16	.957	1.20	1.434	1.674	1.92	2.15	2.39	2.63	2.87	3.11	3.35	3.83	4.30	4.78	5.26	5.74	6.22	6.70	7.17	7.65	8.13	8.61	9.09	9.57
5/8	1.06	1.33	1.594	1.859	2.12	2.39	2.65	2.92	3.19	3.46	3.72	4.25	4.78	5.31	5.84	6.38	6.91	7.44	7.97	8.50	9.03	9.57	10.10	10.63
11/16	1.17	1.46	1.753	2.045	2.34	2.63	2.92	3.22	3.51	3.80	4.09	4.67	5.26	5.84	6.43	7.02	7.60	8.18	8.76	9.35	9.93	10.52	11.11	11.69
3/4	1.28	1.60	1.913	2.232	2.55	2.87	3.19	3.51	3.83	4.15	4.47	5.10	5.75	6.38	7.02	7.65	8.29	8.93	9.57	10.20	10.84	11.48	12.12	12.75
13/16	1.38	1.73	2.072	2.417	2.76	3.11	3.45	3.80	4.14	4.49	4.84	5.53	6.21	6.90	7.60	8.29	8.98	9.67	10.36	11.05	11.74	12.43	13.12	13.81
7/8	1.49	1.86	2.232	2.604	2.98	3.35	3.72	4.09	4.47	4.84	5.20	5.95	6.69	7.44	8.18	8.93	9.67	10.41	11.16	11.90	12.65	13.39	14.13	14.87
15/16	1.60	1.99	2.391	2.789	3.19	3.59	3.99	4.39	4.78	5.18	5.58	6.38	7.18	7.97	8.77	9.57	10.36	11.16	11.95	12.75	13.55	14.34	15.14	15.94
1	1.70	2.13	2.55	2.98	3.40	3.83	4.25	4.68	5.10	5.53	5.95	6.80	7.65	8.50	9.35	10.20	11.05	11.90	12.75	13.60	14.45	15.30	16.15	17.00
1 1/16	1.81	2.26	2.710	3.161	3.61	4.064	4.52	4.97	5.42	5.87	6.32	7.22	8.13	9.03	9.93	10.84	11.74	12.65	13.55	14.45	15.35	16.26	17.16	18.06
1 1/8	1.91	2.39	2.868	3.347	3.83	4.304	4.78	5.26	5.74	6.22	6.70	7.65	8.61	9.57	10.52	11.48	12.43	13.39	14.34	15.30	16.26	17.22	18.17	19.13
1 3/16	2.02	2.52	3.03	3.533	4.04	4.54	5.05	5.56	6.06	6.56	7.07	8.08	9.09	10.10	11.11	12.12	13.12	14.13	15.14	16.15	17.16	18.17	19.18	20.19
1 1/4	2.12	2.66	3.19	3.72	4.25	4.79	5.31	5.85	6.38	6.91	7.44	8.50	9.57	10.63	11.69	12.75	13.81	14.87	15.94	17.00	18.06	19.13	20.19	21.25
1 5/16	2.23	2.79	3.35	3.91	4.46	5.02	5.58	6.14	6.69	7.25	7.81	8.93	10.04	11.16	12.27	13.39	14.50	15.62	16.74	17.85	18.96	20.08	21.20	22.32
1 3/8	2.34	2.92	3.51	4.09	4.67	5.26	5.84	6.43	7.02	7.60	8.18	9.35	10.52	11.69	12.85	14.03	15.20	16.36	17.53	18.70	19.87	21.04	22.21	23.38
1 7/16	2.45	3.06	3.67	4.28	4.89	5.50	6.11	6.72	7.34	7.94	8.56	9.78	11.00	12.22	13.44	14.66	15.88	17.10	18.33	19.55	20.77	21.99	23.22	24.44
1 1/2	2.55	3.19	3.83	4.47	5.10	5.74	6.38	7.02	7.65	8.29	8.93	10.20	11.48	12.75	14.03	15.30	16.58	17.85	19.13	20.40	21.68	22.95	24.23	25.50
1 9/16	2.66	3.32	3.99	4.65	5.32	5.98	6.64	7.31	7.97	8.74	9.30	10.63	11.95	13.28	14.61	15.94	17.27	18.60	19.92	21.25	22.58	23.91	25.24	26.57
1 5/8	2.76	3.45	4.15	4.84	5.52	6.22	6.90	7.60	8.29	8.98	9.67	11.05	12.43	13.81	15.19	16.58	17.96	19.34	20.72	22.10	23.48	24.87	26.25	27.63
1 11/16	2.87	3.59	4.31	5.02	5.74	6.46	7.17	7.89	8.61	9.33	10.04	11.47	12.91	14.34	15.78	17.22	18.65	20.08	21.51	22.95	24.38	25.82	27.26	28.69
1 3/4	2.98	3.72	4.47	5.21	5.95	6.70	7.44	8.19	8.93	9.67	10.42	11.90	13.40	14.88	16.37	17.85	19.34	20.83	22.32	23.80	25.29	26.78	28.27	29.75
1 13/16	3.08	3.85	4.62	5.46	6.16	6.93	7.70	8.48	9.24	10.02	10.79	12.33	13.86	15.40	16.95	18.49	20.03	21.57	23.11	24.65	26.19	27.73	29.27	30.81
1 7/8	3.19	3.99	4.79	5.58	6.38	7.17	7.97	8.77	9.57	10.36	11.15	12.75	14.34	15.94	17.53	19.13	20.72	22.31	23.91	25.50	27.10	28.69	30.28	31.87
1 15/16	3.30	4.12	4.94	5.77	6.59	7.42	8.24	9.06	9.88	10.71	11.53	13.18	14.83	16.47	18.12	19.77	21.41	23.06	24.70	26.35	28.00	29.64	31.29	32.94
2	3.40	4.25	5.10	5.95	6.80	7.65	8.50	9.35	10.20	11.05	11.90	13.60	15.30	17.00	18.70	20.40	22.10	23.80	25.50	27.20	28.90	30.60	32.30	34.00

WEIGHT OF HIGH SPEED STEEL.—High Speed Steel is approximately 10% heavier than Carbon Tool Steel.

WEIGHT OF FLAT BAR STEEL, PER LINEAL FOOT

Thickness Inches	WIDTH—INCHES																							
	5¼	5½	5¾	6	6¼	6½	6¾	7	7¼	7½	7¾	8	8¼	8½	8¾	9	9¼	9½	9¾	10	10¼	10½	11	12
1/16	1.116	1.169	1.222	1.275	1.328	1.381	1.434	1.487	1.540	1.594	1.647	1.70	1.753	1.806	1.859	1.913	1.965	2.019	2.078	2.135	2.178	2.232	2.338	2.55
1/8	2.232	2.338	2.444	2.550	2.656	2.762	2.869	2.975	3.081	3.188	3.294	3.40	3.506	3.612	3.720	3.826	3.931	4.037	4.144	4.250	4.356	4.463	4.676	5.1
3/16	3.35	3.51	3.67	3.83	3.99	4.14	4.30	4.46	4.62	4.78	4.94	5.10	5.26	5.42	5.58	5.74	5.90	6.06	6.22	6.38	6.54	6.70	7.02	7.65
1/4	4.46	4.67	4.89	5.10	5.31	5.53	5.74	5.95	6.16	6.36	6.58	6.80	7.01	7.22	7.43	7.65	7.86	8.08	8.29	8.50	8.71	8.92	9.34	10.20
5/16	5.58	5.84	6.11	6.38	6.64	6.90	7.17	7.44	7.70	7.97	8.23	8.50	8.76	9.03	9.29	9.56	9.83	10.10	10.36	10.62	10.89	11.16	11.68	12.75
3/8	6.69	7.02	7.34	7.65	7.97	8.29	8.61	8.93	9.25	9.57	9.88	10.20	10.52	10.84	11.16	11.48	11.80	12.12	12.44	12.75	13.07	13.39	14.03	15.30
7/16	7.81	8.18	8.56	8.93	9.29	9.67	10.04	10.41	10.78	11.16	11.53	11.90	12.27	12.64	13.02	13.40	13.76	14.14	14.51	14.88	15.25	15.62	16.36	17.85
1/2	8.93	9.35	9.77	10.20	10.63	11.05	11.48	11.90	12.32	12.75	13.18	13.60	14.03	14.44	14.87	15.30	15.73	16.16	16.58	17.00	17.42	17.85	18.70	20.40
9/16	10.04	10.52	11.00	11.48	11.95	12.43	12.91	13.39	13.86	14.34	14.82	15.30	15.78	16.26	16.74	17.22	17.69	18.18	18.65	19.14	19.61	20.08	21.02	22.95
5/8	11.16	11.69	12.22	12.75	13.28	13.81	14.34	14.87	15.40	15.94	16.47	17.00	17.53	18.06	18.59	19.13	19.65	20.19	20.72	21.35	21.78	22.32	23.38	25.50
11/16	12.27	12.85	13.44	14.03	14.61	15.20	15.78	16.36	16.94	17.53	18.12	18.70	19.28	19.86	20.45	21.04	21.62	22.21	22.79	23.38	23.96	24.54	25.70	28.05
3/4	13.39	14.03	14.67	15.30	15.94	16.58	17.22	17.85	18.49	19.13	19.77	20.40	21.04	21.68	22.32	22.96	23.59	24.23	24.86	25.50	26.14	26.78	28.05	30.60
13/16	14.50	15.19	15.88	16.58	17.27	17.95	18.65	19.34	20.03	20.72	21.41	22.10	22.79	23.48	24.17	24.86	25.55	26.24	26.94	27.62	28.32	29.00	30.40	33.15
7/8	15.62	16.36	17.10	17.85	18.60	19.34	20.08	20.83	21.57	22.32	23.05	23.80	24.55	25.30	26.04	26.78	27.52	28.26	29.01	29.75	30.50	31.34	32.72	35.70
15/16	16.74	17.53	18.33	19.13	19.92	20.72	21.51	22.32	23.11	23.91	24.70	25.50	26.30	27.10	27.89	28.69	29.49	30.28	31.08	31.88	32.67	33.48	35.06	38.25
1	17.85	18.70	19.55	20.40	21.25	22.10	22.95	23.80	24.65	25.50	26.35	27.20	28.05	28.90	29.75	30.60	31.45	32.20	33.15	34.00	34.85	35.70	37.40	40.80
1 1/16	18.96	19.87	20.77	21.68	22.58	23.48	24.39	25.29	26.19	27.10	28.00	28.90	29.80	30.70	31.61	32.52	33.41	34.32	35.22	36.12	37.03	37.92	39.74	43.35
1 1/8	20.08	21.04	21.99	22.95	23.91	24.87	25.82	26.78	27.73	28.68	29.64	30.60	31.56	32.52	33.47	34.43	35.38	36.34	37.29	38.25	39.21	40.17	42.08	45.90
1 3/16	21.20	22.21	23.22	24.23	25.23	26.24	27.25	28.26	29.27	30.28	31.29	32.30	33.31	34.32	35.33	36.34	37.35	38.36	39.37	40.38	41.39	42.40	44.42	48.45
1 1/4	22.32	23.38	24.44	25.50	26.56	27.62	28.69	29.75	30.81	31.88	32.94	34.00	35.06	36.12	37.20	38.26	39.31	40.37	41.47	42.50	43.56	44.63	46.76	51.00
1 5/16	23.43	24.54	25.66	26.78	27.90	29.01	30.12	31.22	32.35	33.48	34.59	35.70	36.81	37.93	39.05	40.16	41.28	42.40	43.52	44.64	45.75	46.86	49.08	53.55
1 3/8	24.54	25.71	26.88	28.05	29.22	30.39	31.56	32.72	33.89	35.06	36.23	37.40	38.57	39.74	40.91	42.08	43.25	44.41	45.58	46.75	47.92	49.08	51.42	56.10
1 7/16	25.66	26.88	28.10	29.33	30.55	31.77	32.90	34.21	35.44	36.66	37.88	39.10	40.32	41.54	42.77	44.00	45.22	46.44	47.66	48.88	50.10	51.32	53.76	58.65
1 1/2	26.78	28.05	29.33	30.60	31.88	33.15	34.43	35.70	36.98	38.26	39.53	40.80	42.08	43.35	44.63	45.90	47.18	48.45	49.73	51.00	52.28	53.55	56.10	61.20
1 9/16	27.89	29.22	30.55	31.88	33.20	34.53	35.86	37.19	38.51	39.84	41.17	42.50	43.83	45.16	46.49	47.82	49.14	50.48	51.80	53.14	54.46	55.78	58.42	63.75
1 5/8	29.01	30.39	31.77	33.15	34.53	35.91	37.99	38.67	40.05	41.44	42.82	44.20	45.58	46.96	48.34	49.73	51.10	52.49	53.87	55.25	56.63	58.02	60.78	66.30
1 11/16	30.12	31.55	32.99	34.43	35.86	37.30	38.73	40.16	41.59	43.03	44.47	45.90	47.33	48.76	50.20	51.64	53.07	54.51	55.94	57.38	58.81	60.24	63.10	68.85
1 3/4	31.24	32.73	34.22	35.70	37.19	38.68	40.17	41.65	43.14	44.63	46.12	47.60	49.09	50.58	52.07	53.56	55.04	56.53	58.01	59.50	60.99	62.48	65.45	71.40
1 13/16	32.35	33.89	35.43	36.98	38.52	40.05	41.60	43.14	44.68	46.22	47.76	49.30	50.84	52.38	53.92	55.46	57.00	58.54	60.09	61.62	63.17	64.70	67.80	73.95
1 7/8	33.47	35.06	36.65	38.25	39.85	41.44	43.03	44.63	46.22	47.82	49.40	51.00	52.60	54.20	55.79	57.38	58.97	60.56	62.16	63.75	65.35	66.94	70.52	76.50
1 15/16	34.50	36.23	37.88	39.53	41.17	42.82	44.46	46.12	47.76	49.41	51.05	52.70	54.35	56.00	57.64	59.29	60.94	62.58	64.23	65.88	67.52	69.18	72.46	79.05
2	35.70	37.40	39.10	40.80	42.50	44.20	45.90	47.60	49.30	51.00	52.70	54.40	56.10	57.80	59.50	61.20	62.90	64.60	66.30	68.00	69.70	71.40	74.80	81.60

WEIGHT of HIGH SPEED STEEL.—High Speed Steel is approximately 10% heavier than Carbon Tool Steel.

WEIGHT OF BAR STEEL, LARGER THAN 12 INCHES IN DIAMETER—PER FOOT

Diameter	Pounds	Diameter	Pounds
12 1/8"	395.518	17 7/8"	858.863
12 1/4"	404.246	18 "	870.280
12 3/8"	412.974	18 1/8"	883.105
12 1/2"	421.702	18 1/4"	895.920
12 5/8"	430.430	18 3/8"	908.740
12 3/4"	439.158	18 1/2"	921.560
12 7/8"	447.886	18 5/8"	934.380
13 "	456.615	18 3/4"	947.200
13 1/8"	465.343	18 7/8"	960.020
13 1/4"	474.071	19 "	972.840
13 3/8"	482.799	19 1/8"	985.035
13 1/2"	491.527	19 1/4"	998.230
13 5/8"	500.255	19 3/8"	1010.925
13 3/4"	508.983	19 1/2"	1023.620
13 7/8"	517.711	19 5/8"	1036.315
14 "	526.440	19 3/4"	1049.010
14 1/8"	536.512	19 7/8"	1061.705
14 1/4"	546.585	20 "	1074.400
14 3/8"	556.657	20 1/8"	1088.502
14 1/2"	566.730	20 1/4"	1102.605
14 5/8"	576.802	20 3/8"	1116.707
14 3/4"	586.875	20 1/2"	1130.810
14 7/8"	596.947	20 5/8"	1144.912
15 "	607.020	20 3/4"	1159.015
15 1/8"	617.092	20 7/8"	1173.118
15 1/4"	627.165	21 "	1187.220
15 3/8"	637.237	21 1/8"	1201.322
15 1/2"	647.310	21 1/4"	1215.425
15 5/8"	657.382	21 3/8"	1229.527
15 3/4"	667.455	21 1/2"	1243.630
15 7/8"	677.527	21 5/8"	1257.732
16 "	687.600	21 3/4"	1271.835
16 1/8"	699.017	21 7/8"	1285.937
16 1/4"	710.435	22 "	1300.040
16 3/8"	721.852	22 1/8"	1315.485
16 1/2"	733.270	22 1/4"	1330.930
16 5/8"	744.687	22 3/8"	1346.375
16 3/4"	756.105	22 1/2"	1361.820
16 7/8"	767.522	22 5/8"	1377.265
17 "	778.940	22 3/4"	1392.710
17 1/8"	790.358	22 7/8"	1408.155
17 1/4"	801.777	23 "	1423.600
17 3/8"	813.195	23 1/4"	1454.490
17 1/2"	824.614	23 1/2"	1485.380
17 5/8"	836.030	23 3/4"	1516.270
17 3/4"	847.447	24 "	1547.160

WEIGHT of HIGH SPEED STEEL.—The weight of High Speed Steel is approximately 10% heavier than Carbon Tool Steel.

WEIGHT OF HALF-ROUND, OVAL AND HALF-OVAL BAR STEEL

Half-Round Inch	Oval Inch	Pounds per Foot	Half-Oval Inch	Pounds per Foot
3/8	3/8 x 3/16	.186	3/8 x 3/32	.093
7/16	7/16 x 7/32	.253	7/16 x 7/64	.127
1/2	1/2 x 1/4	.331	1/2 x 1/8	.165
5/8	5/8 x 5/16	.517	5/8 x 5/32	.259
3/4	3/4 x 3/8	.744	3/4 x 3/16	.372
7/8	7/8 x 7/16	1.013	7/8 x 7/32	.507
1	1 x 1/2	1.323	1 x 1/4	.662
1 1/8	1 1/8 x 9/16	1.624	1 1/8 x 9/32	.812
1 1/4	1 1/4 x 5/8	2.067	1 1/4 x 5/16	1.034
1 1/2	1 1/2 x 3/4	2.976	1 1/2 x 3/8	1.488
1 3/4	1 3/4 x 7/8	4.050	1 3/4 x 7/16	2.026
2	2 x 1	5.290	2 x 1/2	2.645

AREA EQUIVALENTS FOR VARIOUS SHAPES

Sides	Name	Area When Dia. of Inscribed Circle = 1	Area When Sides = 1	Length of Side When Perpendicular = 1	Perpendicular When Sides = 1	Radius of Circumscribed Circle When Side = 1	Length of Side When Radius of Circumscribed Circle = 1
3	Triangle	1.299	.433	3.464	.289	.577	1.732
4	Square	1.000	1.000	2.000	.500	.707	1.414
5	Pentagon	.908	1.720	1.453	.688	.851	1.176
6	Hexagon	.866	2.598	1.155	.866	1.000	1.000
7	Heptagon	.843	3.634	.963	1.039	1.152	.868
8	Octagon	.828	4.828	.828	1.207	1.307	.765
9	Nonagon	.819	6.182	.728	1.374	1.462	.684
10	Decagon	.812	7.694	.650	1.539	1.618	.618
11	Nudecagon	.807	9.366	.587	1.703	1.775	.563
12	Dodecagon	.804	11.196	.536	1.866	1.932	.518

Area of any regular polygon = Radius of inscribed circle × number of sides × length of one side ÷ 2.

WEIGHT OF DRILL ROD WIRE PER FOOT

ON BASIS OF ONE CUBIC INCH = .285 POUND

No.	Diameter	Pounds	No.	Diameter	Pounds
Z	.413	.458	2	.219	.129
Y	.404	.437	3	.212	.121
X	.397	.421	4	.207	.115
W	.386	.400	5	.204	.109
V	.377	.383	6	.201	.107
U	.368	.362	7	.199	.106
T	.358	.342	8	.197	.104
S	.348	.325	9	.194	.099
R	.339	.308	10	.191	.096
Q	.332	.294	11	.188	.094
P	.323	.277	12	.185	.092
O	.316	.266	13	.182	.089
N	.302	.242	14	.180	.087
M	.295	.233	15	.178	.085
L	.290	.225	16	.175	.082
K	.281	.212	17	.172	.079
J	.277	.205	18	.168	.076
I	.272	.198	19	.164	.072
H	.266	.188	20	.161	.069
G	.261	.181	21	.157	.066
F	.257	.174	22	.155	.065
E	.250	.167	23	.153	.063
D	.246	.161	24	.151	.061
C	.242	.154	25	.148	.059
B	.238	.150	26	.146	.057
A	.234	.147	27	.143	.055
1	.227	.138	..	....	....

WEIGHT OF DRILL ROD WIRE PER FOOT

ON BASIS OF ONE CUBIC INCH = .285 POUND

No.	Diameter	Pounds	No.	Diameter	Pounds
28	.139	.052	55	.050	.007
29	.134	.048	56	.045	.006
30	.127	.043	57	.042	.005
31	.120	.039	58	.041	.0045
32	.115	.036	59	.040	.0043
33	.112	.034	60	.039	.004
34	.110	.032	61	.038	.0038
35	.108	.031	62	.037	.0037
36	.106	.030	63	.036	.0035
37	.103	.029	64	.035	.0033
38	.101	.028	65	.033	.0029
39	.099	.026	66	.032	.0027
40	.097	.025	67	.031	.0025
41	.095	.024	68	.030	.0024
42	.092	.023	69	.029	.0023
43	.088	.021	70	.027	.0020
44	.085	.019	71	.026	.0018
45	.081	.018	72	.024	.0015
46	.079	.017	73	.023	.0014
47	.077	.016	74	.022	.0013
48	.075	.015	75	.020	.0011
49	.072	.014	76	.018	.0009
50	.069	.013	77	.016	.0007
51	.066	.012	78	.015	.0006
52	.063	.011	79	.014	.0005
53	.058	.009	80	.013	.0004
54	.055	.008	..	....	....

THE BIRMINGHAM WIRE GAUGE

IN DECIMAL AND FRACTIONAL PARTS OF AN INCH, AND THE WEIGHT OF ONE SQUARE FOOT OF SHEET STEEL OF EACH CORRESPONDING THICKNESS

Gauge No.	Decimals of an Inch	Fractions of an Inch	Weight of One Square Foot, in Pounds
00000	.50	$\frac{1}{2}$	20.32
.....	.46875	$\frac{15}{32}$	19.05
0000	.454	..	18.46
....	.4375	$\frac{7}{16}$	17.78
000	.425	..	17.28
...	.40625	$\frac{13}{32}$	16.51
00	.380	..	15.45
..	.375	$\frac{3}{8}$	15.24
..	.34375	$\frac{11}{32}$	13.97
0	.340	..	13.82
..	.3125	$\frac{5}{16}$	12.70
1	.300	..	12.20
..	.296875	$\frac{19}{64}$	12.07
2	.284	..	11.55
..	.28125	$\frac{9}{32}$	11.43
..	.265625	$\frac{17}{64}$	10.80
3	.259	..	10.53
..	.250	$\frac{1}{4}$	10.16
4	.238	..	9.68
..	.234375	$\frac{15}{64}$	9.53
5	.220	..	8.95
..	.21875	$\frac{7}{32}$	8.89
6	.203125	$\frac{13}{64}$	8.26
..	.1875	$\frac{3}{16}$	7.62
7	.180	..	7.32
..	.171875	$\frac{11}{64}$	6.99
8	.165	..	6.71
..	.15625	$\frac{5}{32}$	6.35
9	.148	..	6.09
..	.140625	$\frac{9}{64}$	5.72
10	.134	..	5.45
..	.125	$\frac{1}{8}$	5.08

THE BIRMINGHAM WIRE GAUGE

IN DECIMAL AND FRACTIONAL PARTS OF AN INCH, AND THE WEIGHT OF ONE SQUARE FOOT OF SHEET STEEL OF EACH CORRESPONDING THICKNESS

Gauge No.	Decimals of an Inch	Fractions of an Inch	Weight of One Square Foot, in Pounds
11	.120	..	4.88
12	.109375	$\frac{7}{64}$	4.44
13	.095	..	3.86
..	.09375	$\frac{3}{32}$	3.81
14	.083	..	3.37
..	.078125	$\frac{5}{64}$	3.18
15	.072	..	2.93
16	.065	..	2.64
..	.0625	$\frac{1}{16}$	2.54
17	.058	..	2.36
18	.049	..	1.99
..	.046875	$\frac{3}{64}$	1.91
19	.042	..	1.71
20	.035	..	1.42
21	.032	..	1.30
..	.03125	$\frac{1}{32}$	1.27
22	.028	..	1.14
23	.025	..	1.02
24	.022	..	.89
25	.020	..	.81
26	.018	..	.73
27	.016	..	.65
..	.015625	$\frac{1}{64}$	.64
28	.014	..	.57
29	.013	..	.53
30	.012	..	.49
31	.010	..	.41
32	.009	..	.37
33	.008	..	.33
34	.007	..	.28
35	.005	..	.20
36	.004	..	.16

WIRE GAUGE STANDARDS

IN USE IN THE UNITED STATES

DIMENSIONS OF SIZES IN DECIMAL PARTS OF AN INCH

No. of Wire Gauge	American or Brown and Sharpe	Birmingham or Stubs Wire	Washburn and Moen	British Imperial	Polished Drill Rods or Stubs Steel Wire	United States Legal Standard for Plates	Nearest Millimeter Dimensions	No. of Wire Gauge
000000	.....	....	.....	.464	....	.46875	11.683	000000
00000	.....	....	.....	.432	....	.4375	10.405	00000
0000	.46	.454	.3938	.400	....	.40625	9.266	0000
000	.40964	.425	.3625	.372	....	.375	8.251	000
00	.3648	.38	.3310	.348	....	.34375	7.348	00
0	.32486	.34	.3065	.324	....	.3125	6.544	0
1	.2893	.3	.2830	.300	.227	.28125	5.827	1
2	.25763	.284	.2625	.276	.219	.265625	5.189	2
3	.22942	.259	.2437	.252	.212	.25	4.621	3
4	.20431	.238	.2253	.232	.207	.234375	4.115	4
5	.18194	.22	.2070	.212	.204	.21875	3.665	5
6	.16202	.203	.1920	.192	.201	.203125	3.264	6
7	.14428	.18	.1770	.176	.199	.1875	2.906	7
8	.12849	.165	.1620	.160	.197	.171875	2.588	8
9	.11443	.148	.1483	.144	.194	.15625	2.305	9
10	.10189	.134	.1350	.128	.191	.140625	2.053	10
11	.090742	.12	.1205	.116	.188	.125	1.828	11
12	.080808	.109	.1055	.104	.185	.109375	1.628	12
13	.071961	.095	.0915	.092	.182	.09375	1.449	13
14	.064084	.083	.0800	.080	.180	.078125	1.290	14
15	.057068	.072	.0720	.072	.178	.0703125	1.150	15
16	.05082	.065	.0625	.064	.175	.0625	1.024	16
17	.045257	.058	.0540	.056	.172	.05625	.9116	17

WIRE GAUGE STANDARDS

IN USE IN THE UNITED STATES

DIMENSIONS OF SIZES IN DECIMAL PARTS OF AN INCH

No. of Wire Gauge	American or Brown and Sharpe	Birmingham or Stubs Wire	Washburn and Moen	British Imperial	Polished Drill Rods or Stubs Steel Wire	United States Legal Standard for Plates	Nearest Millimeter Dimensions	No. of Wire Gauge
18	.040303	.049	.0475	.048	.168	.05	.8118	18
19	.03589	.042	.0410	.040	.164	.04375	.7229	19
20	.031961	.035	.0348	.036	.161	.0375	.6439	20
21	.028462	.032	.03175	.032	.157	.034375	.5733	21
22	.025347	.028	.0286	.028	.155	.03125	.5105	22
23	.022571	.025	.0258	.024	.153	.028125	.4547	23
24	.0201	.022	.0230	.022	.151	.025	.4049	24
25	.0179	.02	.0204	.020	.148	.021875	.3604	25
26	.01594	.018	.0181	.018	.146	.01875	.32106	26
27	.014195	.016	.0173	.0164	.143	.0171875	.2860	27
28	.012641	.014	.0162	.0149	.139	.015625	.2545	28
29	.011257	.013	.0150	.0136	.134	.0140625	.2268	29
30	.010025	.012	.0140	.0124	.127	.0125	.2019	30
31	.008928	.01	.0132	.0116	.120	.0109375	.1798	31
32	.00795	.009	.0128	.0108	.115	.01015625	.1600	32
33	.00708	.008	.0118	.0100	.112	.009375	.1425	33
34	.006304	.007	.0104	.0092	.110	.00859375	.1270	34
35	.005614	.005	.0095	.0084	.108	.0078125	.1130	35
36	.005	.004	.0090	.0076	.106	.00703125	.1006	36
37	.004453	....	.....	.0068	.103	.006640625	.0987	37
38	.003965	....	.....	.0060	.101	.00625	.0798	38
39	.003531	....	.....	.0052	.099	.....	.0711	39
40	.003144	....	.....	.0048	.097	.....	.0632	40

FRACTIONS OF AN INCH IN EQUIVALENT DECIMALS

FOR USE IN CONNECTION WITH MICROMETER CALIPERS

Fractions of an Inch		Decimals of an Inch	Fractions of an Inch		Decimals of an Inch
1/64	=	.015625	33/64	=	.515625
1/32	=	.03125	17/32	=	.53125
3/64	=	.046875	35/64	=	.546875
1/16	=	.0625	9/16	=	.5625
5/64	=	.078125	37/64	=	.578125
3/32	=	.09375	19/32	=	.59375
7/64	=	.109375	39/64	=	.609375
1/8	=	.125	5/8	=	.625
9/64	=	.140625	41/64	=	.640625
5/32	=	.15625	21/32	=	.65625
11/64	=	.171875	43/64	=	.671875
3/16	=	.1875	11/16	=	.6875
13/64	=	.203125	45/64	=	.703125
7/32	=	.21875	23/32	=	.71875
15/64	=	.234375	47/64	=	.734375
1/4	=	.250	3/4	=	.750
17/64	=	.265625	49/64	=	.76525
9/32	=	.28125	25/32	=	.78125
19/64	=	.296875	51/64	=	.796875
5/16	=	.3125	13/16	=	.8125
21/64	=	.328125	53/64	=	.828125
11/32	=	.34375	27/32	=	.84375
23/64	=	.359375	55/64	=	.859375
3/8	=	.375	7/8	=	.875
25/64	=	.390625	57/64	=	.890625
13/32	=	.40625	29/32	=	.90625
27/64	=	.421875	59/64	=	.921875
7/16	=	.4375	15/16	=	.9375
29/64	=	.453125	61/64	=	.953125
15/32	=	.46875	31/32	=	.96875
31/64	=	.484375	63/64	=	.984375
1/2	=	.500	1 in.	=	1.000

AVERAGE WEIGHT OF CIRCULAR SAW PLATES

GAUGE

Diam.	5	6	7	8	9	10	11	12	13	14
12	...	...	...	...	.....	..	..	4	3½	3
14	...	...	...	...	.....	..	..	6	5	3½
16	...	...	...	...	9	8	7	6½	5¾	4½
18	...	...	...	12	11	10	9	8	7	6
20	...	...	...	14	13	12	11	9	...	...
22	...	...	...	17	15½	14	13	12	...	...
24	...	...	...	21	19½	18	16	14	...	..
26	...	...	...	25	22	20	19	....	...	.
28	...	...	32	29	27	25	..	....	...	...
30	...	...	39	35	32	29	..	....	...	...
32	...	...	44	40	36	32	..	....	...	..
34	...	...	51	46	41	36	..	....	...	...
36	...	60	54	50	46	42	..	....	...	...
38	...	68	62	56	50	46	..	....	...	...
40	...	74	68	62	56	..	..	....	...	...
42	...	82	74	66	61	..	..	....	...	...
44	...	87	80	73	66	..	..	....	...	...
46	...	100	93	86	80	..	..	....	...	...
48	...	112	104	96	88	..	..	....	...	...
50	...	123	111	100	92	..	..	....	...	...
52	...	135	124	115	106	..	..	....	...	...
54	...	149	136	125	114	..	..	....	...	...
56	...	154	142	132	120	..	..	....	...	...
58	...	168	155	145	135	..	..	....	...	...
60	...	183	168	155	144	..	..	....	...	...
62	...	190	175	162	.....	..	..	....	...	..
64	...	198	185	172	.....	..	..	....	...	...
66	...	214	198	185	.....	..	..	....	...	...
68	247	230	216	...	.....	..	..	....	...	...
70	260	245	230	...	.....	..	..	....	...	..
72	284	255	240	...	.....	..	..	....	...	...

METRIC UNITS, EQUIVALENTS AND COMPARISONS

UNITS

1 Meter = 39.37 Inches
1 Gram = 15.432 Grains
1 Liter = 1.0567 Quarts (liquid)

and the following prefixes are used for subdivisions and multiples:

Milli	$\frac{1}{1000}$	Deka	10
Centi	$\frac{1}{100}$	Hecto	100
Deci	$\frac{1}{10}$	Kilo	1,000
		Myria	10,000

$\frac{1}{25}$ Inch (nearly)	=	1.	Millimeter
1 Inch	=	25.4	Millimeters
		2.54	Centimeters
1 Foot	=	.3048	Meter
1 Yard	=	.9144	Meter
1 Grain	=	.0648	Gram
1 Ounce (Avoirdupois)	=	28.35	Grams
1 Pound (Avoirdupois)	=	453.6	Grams
		.45359	Kilogram
1 Ton (2,240 pounds)	=	1.016	Metric Tonnes
		1016.	Kilograms
1 Ton (2,000 pounds)	=	.9071	Metric Tonne
		907.1	Kilograms

METRIC UNITS, EQUIVALENTS AND COMPARISONS

MEASURES OF WEIGHT

Metric Name	Metric Subdivision or Multiple	Equivalent Avoirdupois Weight
Gram	10 Decigrams 100 Centigrams 1,000 Milligrams	15.432 Grains
Decagram	10 Grams	0.3527 Ounce
Hectogram	100 Grams	3.527 Ounces
Kilogram	100 Decagrams 10 Hectograms	2.2046 Pounds
Myriagram	10 Kilograms	22.046 Pounds
Quintal	100 Kilograms 10 Myriagrams	220.46 Pounds
Millier or Metric Tonne	1,000 Kilograms	2,204.6 Pounds .9842 ton of 2240 lbs. 1.1023 tons of 2000 lbs.

MEASURES OF LENGTH

Metric Name	Metric Subdivision or Multiple	Equivalent
Meter	10 Decimeters 100 Centimeters 1,000 Millimeters	39.37 Inches 3.28083 Feet 1.09361 Yards
Decameter	10 Meters	393.71 Inches 32.81 Feet 10.936 Yards
Hectometer	100 Meters	328.08 Feet 109.36 Yards
Kilometer	1,000 Meters	3,280.83 Feet 1,093.61 Yards
Myriameter	10,000 Meters	6.2137 Miles

METRIC UNITS, EQUIVALENTS AND COMPARISONS—Continued

MEASURES OF CAPACITY

Metric Name	Metric Subdivision or Multiple	Equivalent (Wine or Liquid Measure)
Liter (Cu. Decimeter)	10 Deciliters 100 Centiliters 1,000 Milliliters	.26417 Gallon 1.0567 Quarts 61.023 Cubic Inches .03531 Cubic Foot 2.202 lbs. of water at 62° F.
Decaliter	10 Liters	2.6417 Gallons
Hectoliter	100 Liters	26.417 Gallons
Kiloliter	1,000 Liters	264.17 Gallons

CONVERSION TABLE

POUNDS INTO KILOGRAMS

Pounds	Kilograms	Pounds	Kilograms
0.1	0.0	10	4.5
0.2	0.1	20	9.1
0.3	0.1	30	13.6
0.4	0.2	40	18.1
0.5	0.2	50	22.7
0.6	0.3	60	27.2
0.7	0.3	70	31.8
0.8	0.4	80	36.3
0.9	0.4	90	40.8
1	0.5	100	45.4
2	0.9	200	90.7
3	1.4	300	136.1
4	1.8	400	181.4
5	2.3	500	226.8
6	2.7	600	272.2
7	3.2	700	317.5
8	3.6	800	362.9
9	4.1	900	408.2
		1000	453.6

MILLIMETER EQUIVALENTS IN INCHES

Millimeters		Inches	Millimeters		Inches	Millimeters		Inches
.10	=	.0039	29	=	1.1417	66	=	2.5984
.20	=	.0079	30	=	1.1811	67	=	2.6378
.30	=	.0118	31	=	1.2205	68	=	2.6772
.40	=	.0157	32	=	1.2599	69	=	2.7165
.50	=	.0197	33	=	1.2992	70	=	2.7559
.60	=	.0236	34	=	1.3386	71	=	2.7953
.70	=	.0276	35	=	1.3780	72	=	2.8346
.80	=	.0315	36	=	1.4173	73	=	2.8740
.90	=	.0354	37	=	1.4567	74	=	2.9134
1	=	.0394	38	=	1.4961	75	=	2.9528
2	=	.0787	39	=	1.5354	76	=	2.9921
3	=	.1181	40	=	1.5748	77	=	3.0315
4	=	.1575	41	=	1.6142	78	=	3.0709
5	=	.1969	42	=	1.6536	79	=	3.1102
6	=	.2362	43	=	1.6929	80	=	3.1496
7	=	.2756	44	=	1.7323	81	=	3.1890
8	=	.3150	45	=	1.7717	82	=	3.2283
9	=	.3543	46	=	1.8110	83	=	3.2677
10	=	.3937	47	=	1.8504	84	=	3.3071
11	=	.4331	48	=	1.8988	85	=	3.3465
12	=	.4724	49	=	1.9291	86	=	3.3858
13	=	.5118	50	=	1.9685	87	=	3.4252
14	=	.5512	51	=	2.0079	88	=	3.4646
15	=	.5906	52	=	2.0472	89	=	3.5039
16	=	.6299	53	=	2.0866	90	=	3.5433
17	=	.6693	54	=	2.1260	91	=	3.5827
18	=	.7087	55	=	2.1654	92	=	3.6221
19	=	.7480	56	=	2.2047	93	=	3.6614
20	=	.7874	57	=	2.2441	94	=	3.7008
21	=	.8268	58	=	2.2835	95	=	3.7402
22	=	.8661	59	=	2.3228	96	=	3.7795
23	=	.9055	60	=	2.3622	97	=	3.8189
24	=	.9449	61	=	2.4016	98	=	3.8583
25	=	.9843	62	=	2.4409	99	=	3.8976
26	=	1.0236	63	=	2.4803	100	=	3.9370
27	=	1.0630	64	=	2.5197	...	=	.....
28	=	1.1024	65	=	2.5591	...	=	.....

THERMOMETER CONVERSION SCALE

In the United States and Canada the Fahrenheit thermometer is in almost general use, and in this catalogue reference to degrees of temperature is to that scale.

However, in countries using the metric system, and in many technical treatises and publications, Centigrade readings are common, and the following rules for conversion of one to the other will be found convenient:

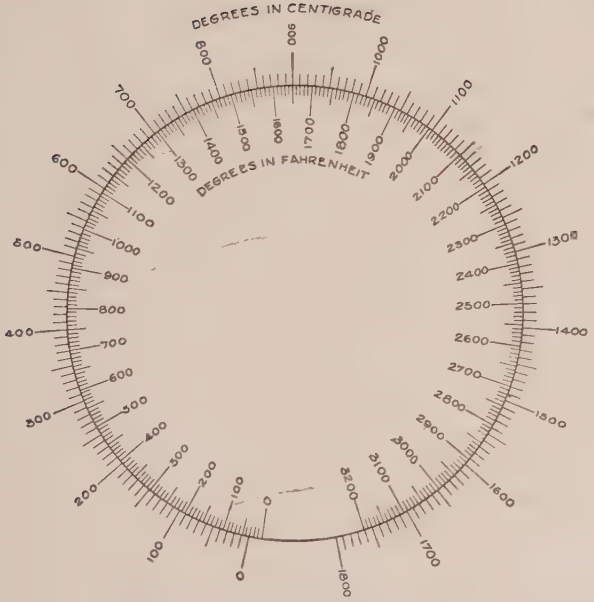
To determine the equivalent Fahrenheit reading from a known Centigrade temperature: multiply the Centigrade reading by 9 and divide the result by 5. Add 32 and the result will be the equivalent in degrees Fahrenheit.

$$F° = \frac{9 \times C°}{5} + 32$$

Centigrade temperatures are secured by multiplying the Fahrenheit reading, less 32, by 5 and dividing the result by 9.

$$C° = \frac{5 \times (F° - 32)}{9}$$

The allowance—plus or minus—of 32 in these formulæ is by reason of the Fahrenheit system using 32° as the freezing point and 212° as the boiling point, while the Centigrade method has 0° as freezing and 100° as the boiling point.



THERMOMETER CONVERSION SCALE

COMPARATIVE TEMPERATURES

DEGREES FAHRENHEIT AND CENTIGRADE

F.	C.	F.	C.	F.	C.	F.	C.	F.	C.	F.	C.
32	0	700	371	1040	560	1380	749	1740	949	2080	1138
212	100	720	382	1060	571	1400	760	1760	960	2100	1149
400	204	740	393	1080	582	1420	771	1780	971	2120	1160
420	216	760	405	1100	593	1440	782	1800	982	2140	1171
440	227	780	416	1120	604	1460	793	1820	993	2160	1182
460	238	800	427	1140	615	1480	804	1840	1004	2180	1193
480	249	820	438	1160	626	1500	816	1860	1015	2200	1204
500	260	840	449	1180	637	1520	827	1880	1026	2220	1216
520	271	860	460	1200	648	1540	838	1900	1038	2240	1227
540	282	880	471	1220	659	1560	849	1920	1049	2260	1238
560	293	900	482	1240	670	1580	860	1940	1060	2280	1249
580	305	920	493	1260	681	1600	871	1960	1071	2300	1260
600	316	940	504	1280	693	1620	882	1980	1082	2320	1271
620	327	960	516	1300	705	1640	893	2000	1093	2340	1283
640	338	980	527	1320	716	1660	904	2020	1105	2360	1294
660	349	1000	538	1340	727	1680	915	2040	1116	2380	1305
680	360	1020	549	1360	738	1700	927	2060	1127	2400	1316

DEGREES CENTIGRADE AND FAHRENHEIT

C.	F.	C.	F.	C.	F.	C.	F.	C.	F.	C.	F.
0	32	350	662	520	968	690	1274	860	1580	1030	1886
100	212	360	680	530	986	700	1292	870	1598	1040	1904
200	392	370	698	540	1004	710	1310	880	1616	1050	1922
210	410	380	716	550	1022	720	1328	890	1634	1060	1940
220	428	390	734	560	1040	730	1346	900	1652	1070	1958
230	446	400	752	570	1058	740	1364	910	1670	1080	1976
240	464	410	770	580	1076	750	1382	920	1688	1090	1994
250	482	420	788	590	1094	760	1400	930	1706	1100	2012
260	500	430	806	600	1112	770	1418	940	1724	1110	2030
270	518	440	824	610	1130	780	1436	950	1742	1120	2048
280	536	450	842	620	1148	790	1454	960	1760	1130	2066
290	554	460	860	630	1166	800	1472	970	1778	1140	2084
300	572	470	878	640	1184	810	1490	980	1796	1150	2102
310	590	480	896	650	1202	820	1508	990	1814	1160	2120
320	608	490	914	660	1220	830	1526	1000	1832	1170	2138
330	626	500	932	670	1238	840	1544	1010	1850	1180	2156
340	644	510	950	680	1256	850	1562	1020	1868	1190	2174

TABLE OF HARDNESS NUMERALS
FOR USE IN THE BRINELL TEST
STEEL BALL OF 10mm. DIAMETER

Diameter of Impression in MM.	Hardness Numeral Pressure in K'gs. 3000	500	Diameter of Impression in MM.	Hardness Numeral Pressure in K'gs. 3000	500	Diameter of Impression in MM.	Hardness Numeral Pressure in K'gs. 3000	500
2.00	946	158	3.70	269	44.8	5.35	124	20.7
2.05	898	150	3.75	262	43.7	5.40	121	20.2
2.10	857	143	3.80	255	42.5	5.45	118	19.7
2.15	817	136	3.85	248	41.3	5.50	116	19.3
2.20	782	130	3.90	241	40.2	5.55	114	19.0
2.25	744	124	3.95	235	39.2	5.60	112	18.7
2.30	713	119	4.00	228	38.0	5.65	109	18.2
2.35	683	114	4.05	223	37.2	5.70	107	17.8
2.40	652	109	4.10	217	36.2	5.75	105	17.5
2.45	627	105	4.15	212	35.3	5.80	103	17.2
2.50	600	100	4.20	207	34.5	5.85	101	16.8
2.55	578	96.3	4.25	202	33.7	5.90	99	16.5
2.60	555	92.5	4.30	196	32.7	5.95	97	16.2
2.65	532	88.7	4.35	192	32.0	6.00	95	15.8
2.70	512	85.3	4.40	187	31.2	6.05	94	15.7
2.75	495	82.5	4.45	183	30.5	6.10	92	15.3
2.80	477	79.5	4.50	179	29.8	6.15	90	15.0
2.85	460	76.7	4.55	174	29.0	6.20	89	14.8
2.90	444	74.0	4.60	170	28.3	6.25	87	14.5
2.95	430	71.7	4.65	166	27.7	6.30	86	14.3
3.00	418	69.7	4.70	163	27.2	6.35	84	14.0
3.05	402	67.0	4.75	159	26.5	6.40	82	13.7
3.10	387	64.5	4.80	156	26.0	6.45	81	13.5
3.15	375	62.5	4.85	153	25.5	6.50	80	13.3
3.20	364	60.7	4.90	149	24.8	6.55	79	13.2
3.25	351	58.5	4.95	146	24.3	6.60	77	12.8
3.30	340	56.7	5.00	143	23.8	6.65	76	12.7
3.35	332	55.3	5.05	140	23.3	6.70	74	12.3
3.40	321	53.5	5.10	137	22.8	6.75	73	12.2
3.45	311	51.8	5.15	134	22.3	6.80	71	11.8
3.50	302	50.3	5.20	131	21.8	6.85	70	11.7
3.55	293	48.8	5.25	128	21.3	6.90	69	11.5
3.60	286	47.7	5.30	126	21.0	6.95	68	11.3
3.65	277	46.2						

All very hard materials such as iron, steel, etc., to be tested at a load of 3000 kilogrammes. Softer materials to be tested at a load of 500 kilogrammes

Numerals given $= \frac{P}{A}$ where P is the pressure in kilogrammes and A is the area of the impression in square millimeters.

In order to determine the approximate ultimate strength of the specimen by this test it will be necessary to establish, by experiment, a coefficient by which to multiply the hardness numerals.

USEFUL RULES

To find the area of a circle, multiply the square of the diameter by .7854.

To find the area of a square, or the section of a flat bar, or of a rectangle, multiply the width by the thickness. In a square these dimensions are the same.

To find the area of an octagon, multiply the square of the diameter of the inscribed circle by .828.

To find the area of a regular hexagon, multiply the square of the diameter of the inscribed circle by .866.

To find the area of a triangle, multiply the width of the base by one-half of the perpendicular height.

To find the area of a trapezoid, multiply the sum of the parallel sides by the perpendicular distance between them, and divide the product by two (2).

The specific gravity of steel is about 7.85, of gray iron about 7.22, and of white iron 7.65. High Speed Steels, however, owing to the percentage of Metallic Alloys present, are denser than ordinary steels. This increased density is not, of course, constant, but in general, High Speed Steels may be considered showing specific gravities 10% in excess of Carbon Tool Steel.

The weight of one cubic foot of steel is approximately 490 pounds.

The weight of one cubic inch of steel is practically .285 pound, and, knowing the cubic inches in any bar or piece, its weight can be obtained by multiplying by this decimal. In ordinary practice, however, it is customary to multiply by the decimal .3, as most commercial steel is finished "full" to the dimensions specified. For the weight of wrought iron, multiply by the decimal .28, and for cast iron, by .26, the results of which calculations will be sufficiently accurate for all ordinary purposes.

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